PATENT ABSTRACTS OF JAPAN

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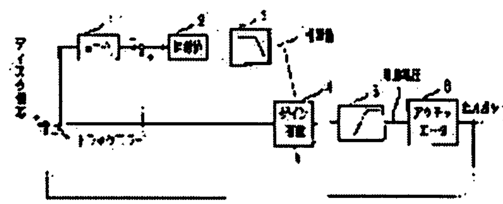
(54) OPTICAL DISK DEVICE

(57)Abstract:

PURPOSE: To improve follow-up ability by applying a repetitive learning control theory to tracking control and focus control.

CONSTITUTION: A shape of disk eccentricity of one before is stored in a learning memory 1, and the fact what the shape of the disk eccentricity of one before of the present eccentricity is changed is calculated. By passing the calculated result through an LPF 3 via an absolute value ALU 2, a mean value of track correlative amounts by several to scores of tracks is calculated. Then, a gain of a tracking control system is increased using a variable gain compensation part 4 based on the calculated correlative amount when track correlation is strong. Further, the gain of the tracking control system is decreased using the compensation part 4 when the track correlation is weak. Thus, a loop gain is decreased when the track correlation is broken due to sudden disturbance such as vibration in on-vehicle, etc., and a scratch, etc., of a disk, and a control system is stabilized.



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CLAIMS

[Claim(s)]
[Claim 1] The tracking actuator for performing tracking actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and is learned by memory. Correlation with the truck deflection in front of 1 truck is detected using the memory which memorizes the truck deflection for the disk 1 above-mentioned rotation. The optical disk unit characterized by carrying out adjustable [of the control band of a tracking control system] according to the amount of truck correlation by carrying out adjustable [of the loop gain of a tracking control system].
[Claim 2] The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. The memory which memorizes the deflection of the focal gap for the disk 1 above-mentioned rotation is used. The optical disk unit characterized by carrying out adjustable [of the control band of a focal control system] according to the amount of face deflection correlation by detecting correlation with the deflection of the focal gap before 1 truck, and carrying out adjustable [of the loop gain of a focal control system].
[Claim 3] The tracking actuator for performing tracking actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and is learned by memory. Correlation with the truck deflection in front of 1 truck is detected using the memory which memorizes the truck deflection for the disk 1 above-mentioned rotation. The optical disk unit characterized by carrying out adjustable [of the balance of control rigidity / low frequency / control system / tracking / and stability] by carrying out adjustable [of the cut off frequency of the low-pass compensating filter of a tracking control system].
[Claim 4] The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. Correlation with the focal gap deflection in front of 1 truck is detected using the memory which memorizes the focal gap deflection for the disk 1 above-mentioned rotation. The optical disk unit characterized by carrying out adjustable [of the balance of control rigidity / low frequency / control system / focal / and stability] by carrying out adjustable [of the cut off frequency of the low-pass compensating filter of a focal control system].
[Claim 5] The tracking actuator for performing tracking actuation of an optical disk, It has the learning-

control section which repeats the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and is learned by memory. By detecting correlation with the truck deflection in front of 1 truck, and carrying out adjustable [of the loop gain of a tracking control system] using the memory which memorizes the truck deflection for the disk 1 above-mentioned rotation The optical disk unit characterized by detecting correlation with the average of the truck error in front of the truck which is carrying out current flattery, and 1 truck, and carrying out adjustable [of the amount of attenuators in the feedforward loop formation of the study compensation section].

[Claim 6] The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. By detecting correlation with the focal gap deflection in front of 1 truck, and carrying out adjustable [of the loop gain of a focal control system] using the memory which memorizes the focal gap deflection for the disk 1 above-mentioned rotation The optical disk unit characterized by detecting correlation with the average of the focal error in front of the truck which is carrying out current flattery, and 1 truck, and carrying out adjustable [of the amount of attenuators in the feedforward loop formation of the study compensation section].

[Claim 7] An optical disk unit given in claim 1 characterized by detecting correlation with the average value of the truck error in front of the truck which is carrying out current flattery, and a 1 - number truck because the memory which memorizes the above-mentioned truck deflection memorizes the truck deflection before disk 1 rotation - number rotation and compares with current truck deflection according to making it connect with a serial partly - claim 6 at either.

[Claim 8] The tracking actuator for performing tracking actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and is learned by memory. The memory which memorizes the truck deflection for the disk 1 above-mentioned rotation because several pieces connect with a serial By memorizing the truck deflection before before [disk 1 rotation] - number rotation, and comparing with current truck deflection While detecting correlation with the average of the truck error in front of the truck which is carrying out current flattery, and a 1 - number truck and carrying out adjustable [of the amount of attenuators in the feedforward loop formation of the study compensation section] The optical disk unit characterized by carrying out adjustable [of a study degree and the control band] according to the amount of truck correlation by carrying out adjustable [of the rope gain of a tracking control system].

[Claim 9] The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. The memory which memorizes the focal gap deflection for the disk 1 above-mentioned rotation because several pieces connect with a serial By memorizing the focal gap deflection before before [disk 1 rotation] - number rotation, and comparing with current focal gap deflection While detecting correlation with the average of the focal error in front of the truck which is carrying out current flattery, and a 1 - number truck and carrying out adjustable [of the amount of attenuators in the feedforward loop formation of the study compensation section] The optical disk unit characterized by carrying out adjustable [of a study degree and the control band] according to the amount of focal correlation by carrying out adjustable [of the rope gain of a focal control system].

[Claim 10] The tracking actuator for performing tracking actuation of an optical disk, Repeat the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control

circuit of the above-mentioned tracking actuator, and it has the learning-control section by memory. It has separately the memory from which the capacity which memorizes the truck deflection of the above-mentioned disk 1 - n rotation quota differs. The optical disk unit characterized by detecting correlation with the truck deflection in front of 1 truck to it, and carrying out adjustable [of the amount of feedback gain of a tracking control system] to it based on the above-mentioned amount of correlation after making weighting on frequency characteristics respectively the eccentric information memorized before 1 - n rotation.

[Claim 11] The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. It has separately the memory from which the capacity which memorizes the deflection of focal gap of the above-mentioned disk 1 - n rotation quota differs. The optical disk unit characterized by detecting correlation with the deflection of the focal gap before 1 truck to it, and carrying out adjustable [of the amount of feedback gain of a focal control system] to it based on the above-mentioned amount of correlation after making weighting on frequency characteristics respectively the face deflection information memorized before 1 - n rotation.

[Claim 12] The tracking actuator for performing tracking actuation of an optical disk, Repeat the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and it has the learning-control section by memory. It has separately the memory from which the capacity which memorizes the truck deflection of the above-mentioned disk 1 - n rotation quota differs. The optical disk unit characterized by memorizing in each memory group, detecting correlation with the truck deflection in front of 1 truck, and carrying out adjustable [of the amount of feedback gain of a tracking control system] based on the above-mentioned amount of correlation after carrying out weighting by the band pass filter with which adjustable [of the Q value] was carried out to each.

[Claim 13] The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. It has separately the memory from which the capacity which memorizes the deflection of focal gap of the above-mentioned disk 1 - n rotation quota differs. The optical disk unit characterized by memorizing in each memory group, detecting correlation with the deflection of the focal gap before 1 truck, and carrying out adjustable [of the amount of feedback gain of a focal control system] based on the above-mentioned amount of correlation after carrying out weighting by the band pass filter with which adjustable [of the Q value] was carried out to each.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] Especially this invention relates to the tracking focus control to which a record regenerative apparatus can carry out record, playback, etc. in all situations about an optical disk unit.
[0002]
[Description of the Prior Art] Drawing 17 -21, drawing 25 -28(b), and Table 1 are woods. Masafumi, Kubo Quantity ** Collaboration: It is drawing and the table showing the configuration of the tracking control of the conventional optical disk carried by "optical disk" Ohm-Sha, Ltd. (May 10, Showa 63 issue).
[0003] The sectional view showing the device in which drawing for drawing in which drawing 17 shows the specification of the deflection of the truck of a videodisk, and drawing 18 to explain the principle of a lens drive, and drawing 19 change the inclination of a reflecting mirror, and a laser beam beam inclination is changed, drawing showing the biaxial drive of a laser beam spot with which drawing 20 used the reflecting mirror, and drawing 21 are drawings showing the example (the 3 spot method) of the auto tracking servo signal detecting method.
[0004] Drawing showing auto TORRA king servo signal detection according [drawing 25] to the push pull method, drawing showing the spot configuration on the quadrisection optical detector with which drawing 26 was used for the astigmatism method, drawing in which drawing 27 shows the relation of focusing, tracking, and radial delivery servo system, and drawing 28 are drawings showing a motion of the objective lens at the time of spiral truck tailing.
[0005] In drawing 17 , in (a), vertical movement (face deflection) of a disk side and (b) express disk radial blurring of a truck, and (c) expresses the fluctuation of rotation (time-axis migration). In drawing 19 , N and S express N pole of a field, and the south pole. It sets to drawing 21 and they are G+, G0, and G about three spots of the light on a truck, respectively. - It carries out. Moreover, it also sets to drawing 25 and a tracking servo signal is a signal from It =I+-I- and the quadrisection optical detector of drawing 20 , respectively I1, I2, I3, and I4 If it carries out Expressing with I0 =(I1+I3)+ (I2+I4), output IF = (I1+I3)- (I2+I4) of an optical detector expresses an astigmatism method auto focusing servo signal.
[0006] In drawing 27 , IP is a signal when using an astigmatism method for auto tracking signal detection at the push pull method and auto focusing signal detection, and is the main signal taken out from an optical detector. In drawing 28 , those of the optical head according [(b)] to a radial feeding servo with migration according [(a)] to an optical head halt are expressed.
[0007] Drawing 22 -24 are Otomo. Yoshiro Work: Drawing where the format of three spots is held using a diffraction grating, drawing showing the example of the tracking servo according [drawing 23] to the 3 spot method, and drawing 24 of drawing showing the configuration of the tracking control of the conventional optical disk carried by "optical disk" Maruzen Co., Ltd. (August 30, Heisei 2 issue) and drawing 22 are drawings showing detection of the focus servo signal by the astigmatism method.
[0008] Drawing 29 and drawing 30 are Murayama. **, Koide **, Yamada Wasaku, Kunikane Truth Work: It is the model Fig. and block diagram of a tracking drive system which are carried by "Optical

disk Technical" radio technical company (common Narimoto year February 10 issue).
[0009] In drawing 29 , each notation expresses following semantics.
0 Absolute-coordinate-system zero 0' : : The objective lens system zero x on a coarse adjustment motor : Objective lens system coordinate xC[absolutely as opposed to a system] : Mass fC of the coefficient-of-viscosity mC:coarse adjustment motor system of the load-rate DT:objective lens system of the mass KT:objective lens system [absolutely as opposed to a system] of the moving part of the driving force mT:objective lens system of the objective lens coordinate fT:objective lens system from coarse adjustment motor coordinate xT:zero 0' : The driving force d of a coarse adjustment motor system (t): Displacement excitation [0010] In drawing 30 , each notation expresses following semantics.
s Force FC carried out the :Laplacian operator XT (s):location [which carried out the Laplace transform] XC (s):location [which carried out the Laplace transform] FT (s):Laplace transform (s) : force which carried out the Laplace transform [0011] With the optical disk unit, the recording surface of a disk is scanned at the optical spot rotating a disk and by moving an optical head to radial. For the effect of the rotation and extraneous vibration, and the machine precision of a disk or a disk unit, a truck moves to the upper and lower sides and right and left violently, or rotation swings. For example, in the case of the videodisk, they are properties like drawing 17 . In order to hold an optical spot with high degree of accuracy on this truck and to perform right signal regeneration, the optical spot is scanned and controlled as shown in Table 1. It detects optically whether the optical spot is scanning the truck top correctly, an optical spot drive is operated by the signal, and a right scan is always performed.
[0012]
[Table 1]

走査方向	目的	手段
ディスク面に垂直 （z軸）	焦点合わせ （オートフォーカスサーボ） 精度±0.5～1μm	光学的に焦点ずれを検出 電磁駆動でレンズをz方向に動かす。
ディスク半径方向 （x軸）	トラック追尾 （トラッキングサーボ） 精度±0.1μm	トラックからのスポットずれを光学的に検出、電磁駆動力でレンズをx方向に動かす。
	再生位置の変更 （ラジアル送りサーボ）	モータで光ヘッドをx方向に移動させる。
トラック接線方向 （y軸）	トラック上の光スポット走査で信号再生 （ディスク回転サーボ） 精度0.1％以下	モータでディスクを回転する。
	再生信号の時間軸補正 （ジッタ補正サーボ）	再生した標準周波数信号とプレーヤの基準信号で位相ずれを検出、電磁駆動で光路中の反射鏡の傾きを変え、光スポットをトラック方向に動かす。

[0013] There are the following two as an optical spot driving method.
(1) The lens driving method : subdivide by the objective lens driving method and the optical head [whole] driving method.
(2) The reflecting mirror rotating method : the device principle for moving an objective lens to the upper

and lower sides (the direction of the z-axis) by electromagnetic force combining a magnet and a coil is shown in drawing 18 . Usually it is the biaxial drive which already carries out the lot addition of a magnet and the coil, and moves a lens also to a laser beam and a right angle (the direction of a x axis). Depending on the case, it may be made 3 shaft drives. An example of a device which changes the direction of a light beam by reflecting mirror rotation is shown in drawing 20 . A reflecting mirror is leaned for a current to a coil with a sink and the produced current. Since the include angle of the laser beam beam which carries out incidence changes to an objective lens, the location to which a focus is connected shifts. These two rotation reflecting mirrors are combined and the device in which an optical spot is driven in x and the direction of y is shown in drawing 19 .
[0014] It is classified into the following four as the detection approach with error.
(1) The 3 spot method (2) push-pull method (3) wobbling method (4) heterodyning technique [0015] Drawing 21 is drawing showing the example (the 3 spot method) of the conventional auto tracking servo. A diffraction grating is put into the laser beam between semiconductor laser and an objective lens, and zero-order and the primary [**] diffracted light are built. Those diffracted lights are G0, G+, and G- on a truck by the objective lens. It is condensed by the spot (refer to this drawing (b)). Each reflected light receives light with a trichotomy optical detector, as shown in this drawing (c). Since the amount which requires G+ and G- for a truck according to it will change if a truck moves by disk rotation etc. to right and left, it is output It =I+-I-. A truck gap is detectable by the low-frequency component. The auto tracking servo using this method is well used for the videodisk player and the DAD player, although there are also troubles, like optical system is complicated and adjustment is difficult since it is extremely stable.
[0016] In order to perform a tracking servo, it detects how much the optical spot is shifted from the location of a right truck. The case of the disk only for readouts, and in the case of the mold disk which can be written in, the approaches of tracking differ. Only according to for readouts, since data are written in, in the mold which can be written in, the pit the guide rail currently engraved beforehand or for tracking is followed that what is necessary is just to carry out the tracking of this to reliance. In the case of the 3 spot method and the latter, generally, the push pull method is used at the former type. Here, drawing 22 and drawing 23 explain the 3 spot method.
[0017] Drawing and drawing 23 to which the format of three spots of the former [drawing 22] is performed using a diffraction grating are drawing showing the example of the tracking servo by the conventional 3 spot method. In order to make three optical spots from the semiconductor laser of a piece, a "diffraction grating" is inserted in the optical path of laser light as shown in drawing 22 . A "diffraction grating" is the glass plate with which much fine parallel lines are engraved, and the parallel light which carried out incidence at right angles to this is divided into the component diffracted by the optical axis of incident light in the two directions of the symmetry, and the component which goes straight on without diffracting.
[0018] Although three optical spots will be obtained if the light divided into these three ways is condensed with a lens, the spot by which a center is not diffracted serves as strongest light, reads this, and uses the optical spot of business, and the taper spot of both sides as an object for tracking. Leaning three spot trains slightly to the direction of a truck, as shown in (1) of drawing 23 a, (2), and (3), right above a truck, the spot of the taper of the both sides arranges the strongest optical spot on both sides of a truck, respectively. It detects whether the reflected light of these three optical spots is received with three photodetectors, the output is measured mutually, and there is any main spot at the core of a right truck. Drawing 23 a carries out image formation of said three optical spots to three sensors A, B, and C with the configuration of the signal detector in this case. The optical spot of both ends carries out image formation to Detectors A and C, respectively, and the strongest central optical spot carries out image formation to Detector B. Detector B is quadrisected and has become a detector for the focus servos of drawing 24 , and combination here. The location where the location of an optical spot is located [location] in the location which can balance a quadrisection photodetector output (that is, an optical spot is in a focal location), and the difference of the photodetector output of A and B both ends becomes zero is in the condition of right tracking. The location of (2) corresponds to this condition in the signal

wave form of drawing 23 b.
[0019] The push pull method shown in drawing 25 is used for optical disk memory equipment comparatively well. It is reflected and incidence of the laser beam irradiated by the pit is carried out to an optical detector. By whether incidence is carried out to the core of a pit, or it has shifted from the core, the intensity distribution of the reflected light change light, as shown in drawing. Then, 2 division optical detector is used and it is output It =I+-I-. It is turned out whether the optical spot has shifted from the truck. Although optical system becomes very easy, it is the method with which control precision worsens under the effect of the inclination of a disk. Each signal when using an astigmatism method for auto tracking signal detection at the push pull method and auto focusing signal detection is taken out from the optical detector of drawing 26 as follows.
The main signal: Ip =(I1+I2)+ (I2+I4)
Auto focusing signal: IF = (I1+I3) - (I2+I4)
Auto-tracking signal: It = (I1+I2) - (I3+I4)
[0020] Drawing 27 is drawing having shown the relation of the conventional focusing, tracking, and a radial feeding servo. At focusing servo system, it is the presenting force IF of two optical detectors for focal gap detection. It puts into one shaft of a biaxial drive, a lens is moved in the direction perpendicular to a disk, and a focus is doubled. It obtrudes by semiconductor laser output change of the light source, or the rate change of a light reflex of a disk, and is Force IF. Usually the system which amends changing is added. Sum output I0 of two optical detectors An example makes the output which carried out division of the presenting force IF a drive amplifier input. a tracking servo system -- presenting force It of two photodetectors for truck gap detection A lens is moved to radial and an optical spot is held on a truck. It is It / I0 similarly here. It amends using etc. If the optical spot is following the spiral truck, it becomes impossible to reach and move an objective lens even to the limitation of the range (**200-300 micrometers) which can move radial (drawing 28 (a)). then, presenting force It an optical head all body motion -- carrying out -- an objective lens -- always -- the movable range of a lens drive -- it is made to move by the core mostly (drawing 28 (b)) That is, although a lens drive is the narrow range, it is a high speed, and although an optical head drive is a low speed, it is moving the optical spot greatly from the most inner track of a disk to the outermost periphery truck.
[0021] The truck on a revolving disk causes a truck deflection by various factors. This truck deflection has not only the frequency component that only synchronized with the rotational frequency of a disk but a high frequency component. Even if there is disturbance, such as vibration, reflection factor fluctuation of a disk, and temperature, it is necessary to make a laser beam follow a truck deflection as servo system.
[0022] (1) If only a tracking drive method objective lens is moved and a truck is made to follow, truck offset will arise, but if the coarse adjustment motor which drives the whole optical pickup is moved to coincidence, offset will mitigate. Although the permission movement magnitude of an objective lens system is based also on optical system, it is about 20 micrometers. The actuator which drives this coarse adjustment motor and objective lens is driven complementary, and there are the following two methods in the two-step servo system which carries out truck flattery of the laser beam.
[0023] ** The 2 steps of lens location sensor loess servo system which drives an actuator and a coarse adjustment motor based on a tracking error signal.
** a tracking error signal -- AKUCHUETA -- driving -- a coarse adjustment motor -- an objective lens -- a variation rate -- the two-step servo system with a lens location sensor driven by the detecting signal.
[0024] (2) Supposing the equation of motion of model drawing 29 which used the lens advancing-side-by-side method actuator supported by the model flat spring of a tracking drive system does not have viscosity in a coarse adjustment motorised system, it is as follows.
[0025]
[Equation 1]
$$m_I \ddot{x} + D_I \dot{x}_I + K_I x_I = f_I$$

$$m_c \ddot{x}_c = f_o - f_I$$

[0026] Since the mass system of an objective lens system and a coarse adjustment motor system is large enough, the reaction force from the actuator to a coarse adjustment motor is disregarded, and it is x=xT+xC. It is [0027], when it takes into consideration and the Laplace transform of the top type is carried out.
[Equation 2]

$$X_c(s) = F_c(s) / m_c \cdot s^2$$

$$X_T(s) = \frac{1}{m_T \cdot s^2 + D_T \cdot s + K_T} \{ F_T(s) - \frac{m_T}{m_c} F_c(s) \}$$

[0028] It becomes. If a block diagram expresses this, it will become like drawing 30 .
[0029] Drawing 31 -36 are C-364 of the 1992 Institute of Electronics, Information and Communication Engineers spring convention lecture collected works (4). Katayama ** Work : It is the theoretical explanatory view of "the study tracking control of the optical disk using DSP." Drawing showing the study limitation of as opposed to the amount of phase margins in drawing 31 , and drawing 32 are the Nyquist diagrams of a control system showing the stability of reiterative type learning control. In drawing 32 , each notation expresses following semantics.
Im: Imaginary-axis Re:real axis H (s) : dynamic characteristics compensator (lead compensation)
G(s): Actuator ||K(s) ||: The amount of gain of a stabilization compensator [0030] The Bode diagram of a control system in which drawing 33 shows the frequency characteristics of a study compensator, and drawing 34 are the learning-control system block diagrams which used DSP. In drawing 34 , each notation expresses following semantics.
A /D :analog-to-digital converter K (s) : stabilization compensator e-LS : Storage section H (s): Dynamic characteristics compensator (lead compensation)
D/A: Digital-to-analog-converter DR:driver G (s): Actuator [0031] Drawing 35 is measured drawing of I/O of a deflection compensator, and drawing 36 is measured drawing of a truck error.
[0032] It is required that the tracking control of an optical disk unit should not spoil stability and a fast response with improvement in recording density, but flattery capacity should be improved. Then, flattery capacity can be improved by leaps and bounds by applying the reiterative type learning-control theory to tracking control and focal control. Moreover, it is realizable with the software servo using DSP (digital signal PUROSSESA).
[0033] Next, the relation between machine learning and stability is explained. Drawing 31 shows the study limitation over the stability of a system. If the amount of phase margins increases from drawing, machine learning will improve, and it turns out especially that the frequency characteristics near a control band are important. This is in ** also from the vector locus of a system to the study stability circle shown in drawing 32 , and by inserting the filter (stabilization filter of learning control) which attenuates the high frequency component of a study loop formation shows that the machine learning and stability of fundamental frequency can improve more.
[0034] The frequency characteristics of the study compensator in the conventional system are shown in drawing 33 . Among drawing, the peak by study becomes so large that the gain of a study loop formation approaches 1, and is proportional to machine learning. In the compensator when drawing 33 shows, it has about 20dB machine learning.
[0035] The conventional block diagram is shown in drawing 34 . This system consists of a multistage IIR mold digital filter, a deflection compensator of the control system of the optical disk constituted by study memory, and a flattery compensator.
[0036] In order to satisfy the stability of drawing 31 in the former, the stabilization compensator shown by H (s) constituted from a multistage digital filter is needed here. Moreover, it is possible by progressing and carrying out the filter configuration of the dynamic characteristics compensator of H (s) to secure the amount of phase margins in case there is no study compensator, and to define the dynamic

characteristics of a learning system.
[0037] Therefore, setup of the dynamic characteristics by H (s) and flattery nature by the study compensator can be separately set up now. Moreover, the above system can be constituted from on one software.
[0038] As an example, an actual example of operation is explained in drawing. Here, the sampling periods of DSP are [3kHz and the amounts of phase margins of 50kHz and a control band] about 60 deg(s).
[0039] Drawing 35 is what showed I/O of the deflection compensator in DSP, and is understood that system deviation is lost mostly after study actuation. At this time, a study compensator is continuing outputting the study result of disk eccentricity.
[0040] Although drawing 36 is what showed the truck error when carrying out 2mm eccentricity of the disk, and the deflection of about 0.7 micrometers remains when there is no learning control, most deflection is lost after the learning control in the same control band. Thus, actual effectiveness can be checked.
[0041] It cannot be overemphasized that the conventional system is similarly [in focal control / completely] realizable.
[0042]
[Problem(s) to be Solved by the Invention] It is required that tracking focus control of the conventional optical disk unit should be constituted as mentioned above, and stability and a fast response should not be spoiled with improvement in recording density, but flattery capacity should be improved.
[0043] The modulation component of the light by high order machine resonance of an actuator and the pit train of a disk mixed as disturbance to the control system, high bandwidth-ization of a control band was barred, when it was going to extend the control band by force, the phase margin decreased, and the problem of a control system oscillating produced the tracking focus control which consists of the conventional direct connection feedback control.
[0044] On the other hand, since the learning-control method mentioned above can raise the flattery capacity over a periodic flattery target, without extending the conventional control band, it can respond to a narrow track system, the big system of eccentricity, and a system with a high disk rotational frequency (system with a high transfer rate).
[0045] However, in the conventional direct connection feedback control, as the learning control mentioned above shown also in a Nyquist diagram, if it converges, looking at the point of (-1 and 0) on the left (0 0), to that (stable principle of nyquist) stable, it must be made to have to turn around the outside of the circle centering on the point of (-1 and 0), and stable allowances will have deteriorated.
[0046] Moreover, learning control (repeat control) memorizes the deflection signal in front of a round term, and since it is the method which carries out feedforward addition of the memorized result at the control system of a basis, when the flattery target which is not periodic is given according to disturbance, such as vibration which joins the blemish and equipment of a disk, it will become equal to mix a noise unnecessary to a control system on the contrary to learn this.
[0047] Therefore, vibration was added and it was required that improvement in the stability of the control system at the time of the blemish of a disk etc. mixing and the effect of the unnecessary non-period component learned by memory should have been lost.
[0048] It was made in order that this invention might solve the above technical problems, and it aims at obtaining the optical disk unit which can improve flattery capacity by leaps and bounds by applying the reiterative type learning-control theory to tracking control and focal control.
[0049]
[Means for Solving the Problem] A tracking actuator for the optical disk unit concerning claim 1 of this invention to perform tracking actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and is learned by memory. Using the memory which memorizes the truck deflection for the disk 1 above-mentioned rotation,

correlation with the truck deflection in front of 1 truck is detected, and it carries out adjustable [of the control band of a tracking control system] according to the amount of truck correlation by carrying out adjustable [of the loop gain of a tracking control system].

[0050] Moreover, the optical disk unit concerning claim 2 of this invention The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. Using the memory which memorizes the deflection of the focal gap for the disk 1 above-mentioned rotation, correlation with the deflection of the focal gap before 1 truck is detected, and it carries out adjustable [of the control band of a focal control system] according to the amount of face deflection correlation by carrying out adjustable [of the loop gain of a focal control system].

[0051] Moreover, the optical disk unit concerning claim 3 of this invention The tracking actuator for performing tracking actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and is learned by memory. Correlation with the truck deflection in front of 1 truck is detected using the memory which memorizes the truck deflection for the disk 1 above-mentioned rotation. It carries out adjustable [of the balance of control rigidity / low frequency / control system / tracking / and stability] by carrying out adjustable [of the cut off frequency of the low-pass compensating filter of a tracking control system].

[0052] Moreover, the optical disk unit concerning claim 4 of this invention The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. Correlation with the focal gap deflection in front of 1 truck is detected using the memory which memorizes the focal gap deflection for the disk 1 above-mentioned rotation. It carries out adjustable [of the balance of control rigidity / low frequency / control system / focal / and stability] by carrying out adjustable [of the cut off frequency of the low-pass compensating filter of a focal control system].

[0053] Moreover, the optical disk unit concerning claim 5 of this invention The tracking actuator for performing tracking actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and is learned by memory. By detecting correlation with the truck deflection in front of 1 truck, and carrying out adjustable [of the loop gain of a tracking control system] using the memory which memorizes the truck deflection for the disk 1 above-mentioned rotation Correlation with the average of the truck error in front of the truck which is carrying out current flattery, and 1 truck is detected, and it carries out adjustable [of the amount of attenuators in the feedforward loop formation of the study compensation section].

[0054] Moreover, the optical disk unit concerning claim 6 of this invention The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. By detecting correlation with the focal gap deflection in front of 1 truck, and carrying out adjustable [of the loop gain of a focal control system] using the memory which memorizes the focal gap deflection for the disk 1 above-mentioned rotation Correlation with the average of the focal error in front of the truck which is carrying out current flattery, and 1 truck is detected, and it carries out adjustable [of the amount of attenuators in the feedforward loop formation of the study compensation section].

[0055] Moreover, the optical disk unit concerning claim 7 of this invention is that the memory which

memorizes the above-mentioned truck deflection makes it connect with a serial partly, memorizes the truck deflection before disk 1 rotation - number rotation, is comparing with current truck deflection, and detects correlation with the average of the truck error in front of the truck which is carrying out current flattery, and a 1 - number truck.

[0056] Moreover, the optical disk unit concerning claim 8 of this invention The tracking actuator for performing tracking actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and is learned by memory. The memory which memorizes the truck deflection for the disk 1 above-mentioned rotation because several pieces connect with a serial By memorizing the truck deflection before before [disk 1 rotation] - number rotation, and comparing with current truck deflection While detecting correlation with the average of the truck error in front of the truck which is carrying out current flattery, and a 1 - number truck and carrying out adjustable [of the amount of attenuators in the feedforward loop formation of the study compensation section] According to the amount of truck correlation, it carries out adjustable [of a study degree and the control band] by carrying out adjustable [of the rope gain of a tracking control system].

[0057] Moreover, the optical disk unit concerning claim 9 of this invention The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. The memory which memorizes the focal gap deflection for the disk 1 above-mentioned rotation because several pieces connect with a serial By memorizing the focal gap deflection before before [disk 1 rotation] - number rotation, and comparing with current focal gap deflection While detecting correlation with the average of the focal error in front of the truck which is carrying out current flattery, and a 1 - number truck and carrying out adjustable [of the amount of attenuators in the feedforward loop formation of the study compensation section] According to the amount of focal correlation, it carries out adjustable [of a study degree and the control band] by carrying out adjustable [of the rope gain of a focal control system].

[0058] Moreover, the optical disk unit concerning claim 10 of this invention The tracking actuator for performing tracking actuation of an optical disk, Repeat the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and it has the learning-control section by memory. It has separately the memory from which the capacity which memorizes the truck deflection of the above-mentioned disk 1 - n rotation quota differs. After making weighting on frequency characteristics respectively the eccentric information memorized before 1 - n rotation, correlation with the truck deflection in front of 1 truck is detected to it, and it carries out adjustable [of the amount of feedback gain of a tracking control system] to it based on the above-mentioned amount of correlation.

[0059] Moreover, the optical disk unit concerning claim 11 of this invention The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. It has separately the memory from which the capacity which memorizes the deflection of focal gap of the above-mentioned disk 1 - n rotation quota differs. After making weighting on frequency characteristics respectively the face deflection information memorized before 1 - n rotation, correlation with the deflection of the focal gap before 1 truck is detected to it, and it carries out adjustable [of the amount of feedback gain of a focal control system] to it based on the above-mentioned amount of correlation.

[0060] Moreover, the optical disk unit concerning claim 12 of this invention The tracking actuator for performing tracking actuation of an optical disk, Repeat the above-mentioned periodicity error amount for every period to the truck error signal which has the periodicity which synchronized with rotation of

the follow-up control section and the motor which have the control circuit of the above-mentioned tracking actuator, and it has the learning-control section by memory. It has separately the memory from which the capacity which memorizes the truck deflection of the above-mentioned disk 1 - n rotation quota differs. After carrying out weighting by the band pass filter with which adjustable [of the Q value] was carried out to each, it memorizes in each memory group, correlation with the truck deflection in front of 1 truck is detected, and it carries out adjustable [of the amount of feedback gain of a tracking control system] based on the above-mentioned amount of correlation.

[0061] Moreover, the optical disk unit concerning claim 13 of this invention The focal actuator for performing focal actuation of an optical disk, It has the learning-control section which repeats the above-mentioned periodicity error amount for every period to the focal error signal which has the periodicity which synchronized with rotation of the follow-up control section and the motor which have the control circuit of the above-mentioned focal actuator, and is learned by memory. It has separately the memory from which the capacity which memorizes the deflection of focal gap of the above-mentioned disk 1 - n rotation quota differs. After carrying out weighting by the band pass filter with which adjustable [of the Q value] was carried out to each, it memorizes in each memory group, correlation with the deflection of the focal gap before 1 truck is detected, and it carries out adjustable [of the amount of feedback gain of a focal control system] based on the above-mentioned amount of correlation.

[0062]

[Function] It is carrying out adjustable [of the loop gain of a tracking control system] to the system deviation in front of 1 truck of the truck error signal in a control system, and when correlation is strong (the form of a truck error has the almost same form as 1 truck front), a control band is raised and the control which attached greater importance than to stability to flattery nature is made to perform in the optical disk unit concerning claim 1 of this invention. Conversely, when correlation is weak, adaptation actuation is performed by making a control system into a property which makes greater importance attach than to flattery nature to stability by lowering a control band.

[0063] Moreover, it is carrying out adjustable [of the loop gain of a focal control system] to the system deviation in front of 1 truck of the focal gap signal in a control system, and when correlation is strong (the form of focal gap has the almost same form as 1 truck front), a control band is raised and the control which attached greater importance than to stability to flattery nature is made to perform in the optical disk unit concerning claim 2 of this invention. Conversely, when correlation is weak, adaptation actuation is performed by making a control system into a property which makes greater importance attach than to flattery nature to stability by lowering a control band.

[0064] Moreover, in the optical disk unit concerning claim 3 of this invention, adaptation actuation is performed by considering as a property which a cut off frequency is made high and the capacity of the control system to low-pass - a mid-range is raised, and makes a cut off frequency low when correlation is weak, and is limited to improvement in the capacity of a low-pass control system by carrying out adjustable [of the cut off frequency of the low-pass compensating filter of a tracking control system] to the system deviation in front of 1 truck of the truck error signal in a control system when correlation is strong.

[0065] Moreover, in the optical disk unit concerning claim 4 of this invention, adaptation actuation is performed by considering as a property which a cut off frequency is made high and the capacity of the control system to low-pass - a mid-range is raised, and makes a cut off frequency low when correlation is weak, and is limited to improvement in the capacity of a low-pass control system by carrying out adjustable [of the cut off frequency of the low-pass compensating filter of a focal control system] to the system deviation in front of 1 truck of the focal gap signal in a control system when correlation is strong.

[0066] Moreover, in the optical disk unit concerning claim 5 of this invention, correlation with the average of the truck error in front of the truck which is carrying out current flattery to the system deviation in front of 1 truck of the truck error signal in a control system, and 1 truck is detected, and adaptation actuation is performed by carrying out adjustable [of the amount of attenuators in the feedforward of the study compensation section].

[0067] Moreover, in the optical disk unit concerning claim 6 of this invention, correlation with the average of the focal error in front of the truck which is carrying out current flattery to the system deviation in front of 1 truck of the focal gap signal in a control system, and 1 truck is detected, and adaptation actuation is performed by carrying out adjustable [of the amount of attenuators in the feedforward of the study compensation section].
[0068] Moreover, in the optical disk unit concerning claim 7 of this invention, the truck deflection before disk 1 rotation - number rotation is memorized by the memory which memorizes the above-mentioned truck deflection being partly connected to a serial, and adaptation actuation is performed by considering as the property that correlation with the average of the truck error in front of the truck which is carrying out current flattery, and a 1 - number truck is detected by comparing with current truck deflection.
[0069] Moreover, when correlation is strong, while raising the control band of the loop gain of a tracking control system to the average of the system deviation in front of the 1 - number truck of a truck error signal, the feedforward gain of learning control is brought close to 1, and nearly perfect repeat learning control is made to perform in the optical disk unit concerning claim 8 of this invention. Conversely, when correlation is weak, while lowering the control band of the loop gain of a tracking control system, adaptation actuation is performed by considering as the property of the conventional direct connection feedback loop of repeating a control system by setting feedback gain of learning control to about 0 repeatedly, and not using control.
[0070] Moreover, when correlation is strong, while raising the control band of the loop gain of a focal control system to the average of the system deviation in front of the 1 - number truck of a focal gap signal, the feedforward gain of learning control is brought close to 1, and nearly perfect repeat learning control is made to perform in the optical disk unit concerning claim 9 of this invention. Conversely, when correlation is weak, while lowering the control band of the loop gain of a focal control system, adaptation actuation is performed by considering as the property of the conventional direct connection feedback loop of repeating a control system by setting feedback gain of learning control to about 0 repeatedly, and not using control.
[0071] Moreover, it sets to the optical disk unit concerning claim 10 of this invention. As opposed to the correlation value of the truck error signal of a before [1 - n truck of the truck error signal in a control system] For example, while making the cut off frequency of a filter low at the correlation value (before number - n truck) using old information and removing a noise component enough It is made for the noise or disturbance in old information not to influence a correlation value by making the cut off frequency of a filter high at the correlation value using new information, and giving weighting which utilizes all information if possible.
[0072] Moreover, it sets to the optical disk unit concerning claim 11 of this invention. While making the cut off frequency of a filter low at the correlation value (before number - n truck) using old information and removing a noise component enough as opposed to the correlation value of the focal gap signal of a before [1 - n truck of the focal gap signal in a control system] It is made for the noise or disturbance in old information not to influence a correlation value by making the cut off frequency of a filter high at the correlation value using new information, and giving weighting which utilizes all information if possible.
[0073] Moreover, it sets to the optical disk unit concerning claim 12 of this invention. As opposed to the correlation value of the truck error signal of a before [1 - n truck of the truck error signal in a control system] For example, while making Q value of a band pass filter high at the correlation value (before number - n truck) using old information and removing a noise component enough It is made for the noise or disturbance in old information not to influence a correlation value by making Q value of a band pass filter low at the correlation value using new information, and giving weighting which utilizes all information if possible.
[0074] Moreover, it sets to the optical disk unit concerning claim 13 of this invention. While making Q value of a band pass filter high at the correlation value (before number - n truck) using old information and removing a noise component enough as opposed to the correlation value of the focal gap signal of a

before [1 - n truck of the focal gap signal in a control system] It is made for the noise or disturbance in old information not to influence a correlation value by making Q value of a band pass filter low at the correlation value using new information, and giving weighting which utilizes all information if possible.

[0075]
[Example]
Example 1 drawing 1 is a block diagram for carrying out correlation detection in the optical disk unit of the example 1 of this invention. In drawing, in 1, study memory and 2 show an absolute value and 3 shows a low pass filter. Drawing 2 is a block diagram for carrying out correlation detection in the optical disk control device constituted so that it might carry out adjustable [of the loop gain of a control system] with the amount of truck correlation. As for the adjustable gain compensation section and 5, in drawing, 4 is [a phase lead network and 6] tracking actuators.
[0076] Next, actuation of an example is explained. When the form of the disk eccentricity in front of one is memorized by the study memory in drawing 2 , and the forms of the present disk eccentricity and the disk eccentricity in front of one compute how it is changing, apply an absolute value to this calculation result and let a low pass filter pass by comparing with the form of the present eccentricity, the average of the amount of truck correlation for a number - dozens trucks is computed.
[0077] Based on the amount of truck correlation computed by the above, when truck correlation is strong, the gain of a tracking control system is raised using the adjustable gain compensation section. Moreover, when truck correlation is weak, the gain of a tracking control system is lowered using the adjustable gain compensation section. Thus, when are constituted and truck correlation collapses in sudden disturbance, such as vibration in mount etc., and a blemish of a disk, a loop gain falls, and a control system is stabilized. Thus, it is easy to constitute from software which is represented by DSP in the system which has adjustable gain, memory, and an absolute value.
[0078] Other optical disk units are obtained by replacing the tracking actuator in the above-mentioned system with a focal actuator. When it remembers by memory that the form of the face deflection of the disk in front of one applies this thing to a focus servo, and the forms of the face deflection of a current disk and the face deflection of the disk in front of one compute how it is changing, apply an absolute value to this calculation result and let a low pass filter pass by comparing with the form of current face deflection, the average of the amount of focal correlation for a number - dozens trucks is computed.
[0079] Based on the amount of focal correlation computed by the above, when focal correlation is strong, the gain of a focal control system is raised using the adjustable gain compensation section. Moreover, when focal correlation is weak, the gain of a focal control system is lowered using the adjustable gain compensation section. Thus, when are constituted and focal correlation collapses in sudden disturbance, such as vibration in mount etc., and a blemish of a disk, a loop gain falls, and a control system is stabilized. Thus, it is easy to constitute from software which is represented by DSP in the system which has adjustable gain, memory, and an absolute value.
[0080] Example 2 drawing 3 is a block diagram for carrying out correlation detection in the optical disk unit of the example 2 of this invention. In drawing, 7 shows the low-pass compensating filter which can carry out adjustable [of the cut off frequency]. When the amount of correlation is strong, this low-pass compensating filter makes a cut off frequency high, raises the capacity of the control system to low-pass - a mid-range, when the amount of correlation is weak, makes a cut off frequency low and limits it to improvement in the capacity of a low-pass control system.
[0081] Next, actuation of an example is explained. Generally, when correlation is weak, the vibration at the time of mount and carrying and vibration by the blemish of a disk get across to an optical disk. The frequency of the vibration at this time has the peak of a big vibration before and after several Hz - dozens of Hz. Therefore, when disturbance exists by raising the servo gain which is several Hz - dozens of Hz when truck correlation is weak, high flattery capacity can be maintained, and deflection can be stopped small. However, when the gain of low-pass - a mid-range is raised too much in this way, the phase near a control band deteriorates by the circumference of the phase of a low-pass compensating filter, and there is a problem which becomes unstable. However, since it is temporary, as soon as

functionality is recovered, if the form of low-pass compensation is returned, stable allowances will revitalize lack of the truck correlation by the above-mentioned vibration etc. Thus, when there is sudden disturbance, such as vibration and a blemish, by making reduction gain raise in an instant, tracking flattery capacity can be secured and high stability can be acquired in the usual actuation.

[0082] Next, other optical disk units are described. Although drawing 3 showed the case where the low-pass compensating filter which can carry out adjustable [of the cut off frequency] to a tracking control system in an optical disk unit was applied, even when it is a focal control system, it can respond with constituting similarly. Generally, when correlation is weak, the vibration at the time of mount and carrying and vibration by the blemish of a disk get across to an optical disk. The frequency of the vibration at this time is several Hz - dozens of Hz. It has the peak of a big vibration forward and backward. Therefore, when focal correlation is weak, it is several Hz - dozens of Hz. When disturbance exists by raising servo gain, high flattery capacity can be maintained, and deflection can be stopped small. However, when the gain of low-pass - a mid-range is raised too much in this way, the phase near a control band deteriorates by the circumference of the phase of a low-pass compensating filter, and there is a problem which becomes unstable. However, since it is temporary, as soon as functionality is recovered, if the form of low-pass compensation is returned, stable allowances will revitalize lack of the focal correlation by the above-mentioned vibration etc. Thus, when there is sudden disturbance, such as vibration and a blemish, by making reduction gain raise in an instant, focal flattery capacity can be secured and high stability can be acquired in the usual actuation.

[0083] Example 3 drawing 4 is the block diagram showing the control system to which the loop gain of a control system is changed while it detects truck correlation in the optical disk unit of the example 3 of this invention and changes the study degree of repeat control. As for an attenuator and 9, in drawing, 8 is [a low pass filter and 10] study memory.

[0084] Next, actuation is explained. The conditions for stability of the Nyquist diagram in general classical control theory are said to be stable if a vector locus progresses looking at the point of (-1 and 0) on the left. However, since the point conventionally noted as conditions for stability will change to a circle if learning control is performed, the part destabilizing factor increases. Since the radius of a circle is the amount of gain of a repeat loop formation, when performing perfect study (at the time of 100% of circle), circle conditions (90 or more degs of phase margins near a control band are taken) must be satisfied. Since it is difficult actually to satisfy the above-mentioned circle conditions, a circle is made small by the filter or the attenuator, and maintaining stability is performed.

[0085] By the present repeat learning-control method, it is mentioned that the frequency domain which can improve and learns flattery capacity as an advantage, without raising low-pass gain (** which does not extend a band as a result) can be set up at arbitration in the range which conditions for stability allow. Moreover, repeat compensation gain can set steady-state deviation to 0 in the frequency domain of 1. On the other hand, it needs to be satisfied with 100% of study of the circle conditions in a Nyquist diagram as demerit, and there is a fault to which stable allowances become small compared with the configuration of only the conventional series compensation machine, so that machine learning is improved. Moreover, also learning the unnecessary signal in disturbance, vibration, a blemish, etc. was mentioned as a trouble from the former.

[0086] Since there are the above troubles in the conventional repeat control system, it is desirable to change the study degree of repeat control. However, since repeat machine learning falls when truck correlation is weak, big deflection as a result remains. Then, when truck correlation is weak, the gain of a control system is made to raise by carrying out adjustable [of the gain of the control system of a loop formation], and the flattery capacity of a control system over disturbance is raised. Since the control band is suppressing the machine learning of learning control low by the rise of the gain of the above-mentioned control system to it even if the riser phase margin deteriorates in coincidence, a control system does not become unstable. When truck correlation is strong, a system with powerful flattery capacity is realizable to synchronicity, and truck correlation will be weak, namely, disturbance will mix if a control system is constituted as mentioned above, flattery capacity has strong composition to disturbance by the rise of control gain.

[0087] Next, other optical disk units are described. Since repeat machine learning will fall when focal correlation is weak if constituted in focal control as well as the case of tracking control, big deflection as a result remains. Then, when focal correlation is weak, the gain of a control system is made to raise by carrying out adjustable [of the gain of the control system of a loop formation], and the flattery capacity of a control system over disturbance is raised. Since the control band is suppressing the machine learning of learning control low by the rise of the gain of the above-mentioned control system to it even if the riser phase margin deteriorates in coincidence, a control system does not become unstable. When focal correlation is strong, a system with powerful flattery capacity is realizable to synchronicity, and focal correlation will be weak, namely, disturbance will mix if a control system is constituted as mentioned above, flattery capacity has strong composition to disturbance by the rise of control gain.
[0088] Example 4 drawing 5 is a block diagram for carrying out correlation detection in the optical disk unit of the example 4 of this invention. In drawing, 11 shows study memory.
[0089] Next, actuation of drawing 5 is explained. Although examples 1-3 explained memorizing the disk eccentricity in front of 1 period in memory, it is desirable to carry out the memory storage of the disk eccentricity in front of 2 - 3 period in fact, and to detect the total amount of correlation. In drawing 6 , study memory has connected with a serial for memorizing the truck eccentricity of a term several [past] rounds, and it is **. A difference with the present truck eccentricity of the truck eccentricity of a before [several before / 1 period / - round term] can be respectively taken out by taking the difference of the signal line taken out from between each memory, and the present truck error. The amount of correlation in front of a before [1 truck] - number truck is detectable by taking an absolute value for it according to an individual. These amounts of absolute values can be added and the average amount of correlation of a before [a number truck] can be obtained by filtering with a low pass filter 3. The more exact amount of correlation which cannot be easily influenced by sudden disturbance, a sudden blemish, etc. can be obtained by obtaining such an average amount of correlation.
[0090] A difference with the present face deflection of the face deflection of a before [several before / 1 period / - round term] can be respectively taken out by taking the difference of the signal line which was similarly taken out from between each memory in focal control, and the present focal error. The amount of correlation in front of a before [1 truck] - number truck is detectable by taking an absolute value for it according to an individual. These amounts of absolute values can be added and the average amount of correlation of a before [a number truck] can be obtained by filtering by the digital filter 3. The more exact amount of correlation which cannot be easily influenced by sudden disturbance, a sudden blemish, etc. can be obtained by obtaining such an average amount of correlation.
[0091] Next, actuation of drawing 6 is explained. the system of drawing 6 -- the above -- it is a block diagram for carrying out adjustable [of the loop gain of a control system] using the average amount of correlation. When the study memory shown in the example 1 uses the one amount of correlation detection, the amount of correlation will change with the blemish of a disk, defects or track jumps, etc. sharply. In the system by which the average amount of correlation is obtained like drawing 5 , when a blemish etc. exists, the average amount of correlation seldom changes. consequently, a sudden blemish -- extremely, by short-time vibration, it does not change, but the amount of correlation changes only to the big blemish of continuous disturbance or a disk by long duration to some extent, and the gain of a control system carries out adjustable [of the gain of a control system]. Therefore, a control system more stable than an example 1 can be built.
[0092] the same -- focal control -- also setting -- the above -- if it can be made to carry out adjustable [of the loop gain of a control system] using the average amount of correlation -- a sudden blemish -- extremely, by short-time vibration, it cannot change, but the amount of correlation can change only to the big blemish of disturbance continuous to some extent at a long time, or a disk, and the gain of a control system carries out adjustable [of the gain of a control system], and can build a stable focal control system.
[0093] Drawing 7 is a block diagram with being average for [in an optical disk unit] carrying out correlation detection and carrying out adjustable [of the cut off frequency].
[0094] Next, actuation of drawing 7 is explained. Generally, when correlation is weak, the vibration at

the time of mount and carrying and vibration by the blemish of a disk get across to an optical disk. The frequency of the vibration at this time has the peak of a big vibration before and after several Hz - dozens of Hz. Therefore, when disturbance exists by raising the servo gain which is several Hz - dozens of Hz when truck correlation is weak, high flattery capacity can be maintained, and deflection can be stopped small. However, when the gain of low-pass - a mid-range is raised too much in this way, the phase near a control band deteriorates by the circumference of the phase of a low-pass compensating filter, and there is a problem which becomes unstable. However, since it is temporary, as soon as functionality is recovered, if the form of low-pass compensation is returned, stable allowances will revitalize lack of the truck correlation by the above-mentioned vibration etc.

[0095] When there is sudden disturbance, such as such vibration and a blemish, by making low-pass gain raise in an instant, flattery capacity can be secured and high stability can be acquired in the usual actuation. Although drawing 7 showed the case where the low-pass compensating filter which can carry out adjustable [of the cut off frequency] to a tracking control system in an optical disk unit was applied, even when it is a focal control system, it can respond with constituting similarly. Furthermore, in this system, since detection of truck correlation serves as the average amount of correlation not only before 1 period but in front of several round term, carrying out malfunction by the blemish, a defect, etc. is lost.

[0096] Example 5 drawing 8 is the block diagram showing the control system to which the loop gain of a control system is changed while it detects truck correlation in the optical disk unit of the example 5 of this invention and changes the study degree of repeat control.

[0097] Next, actuation is explained. The conditions for stability of the Nyquist diagram in general classical control theory are said to be stable if a vector locus progresses looking at the point of (-1 and 0) on the left. However, since the point conventionally noted as conditions for stability will change to a circle if learning control is performed, the part destabilizing factor increases. Since the radius of a circle is the amount of gain of a repeat loop formation, when performing perfect study (at the time of 100% of circle), circle conditions (90 or more degs of phase margins near a control band are taken) must be satisfied. Since it is difficult actually to satisfy the above-mentioned circle conditions, a circle is made small by the filter or the attenuator, and maintaining stability is performed.

[0098] By the present repeat learning-control method, it is mentioned that the frequency domain which can improve and learns flattery capacity as an advantage, without raising low-pass gain (** which does not extend a band as a result) can be set up at arbitration in the range which conditions for stability allow. Moreover, repeat compensation gain can set steady-state deviation to 0 in the frequency domain of 1. On the other hand, it needs to be satisfied with 100% of study of the circle conditions in a Nyquist diagram as demerit, and there is a fault to which stable allowances become small compared with the configuration of only the conventional series compensation machine, so that machine learning is improved. Moreover, also learning the unnecessary signal in disturbance, vibration, a blemish, etc. was mentioned as a trouble from the former.

[0099] Since there are the above troubles in the conventional repeat control system, it is desirable to change the study degree of repeat control. However, since repeat machine learning falls when truck correlation is weak, big deflection as a result remains. Then, when truck correlation is weak, the gain of a control system is made to raise by carrying out adjustable [of the gain of the control system of a loop formation], and the flattery capacity of a control system over disturbance is raised. Since the control band is suppressing the machine learning of learning control low by the rise of the gain of the above-mentioned control system to it even if the riser phase margin deteriorates in coincidence, a control system does not become unstable. When truck correlation is strong, a system with powerful flattery capacity is realizable to synchronicity, and truck correlation will be weak, namely, disturbance will mix if a tracking control system is constituted as mentioned above, flattery capacity has strong composition to disturbance by the rise of control gain. Carrying out malfunction by the blemish, a defect, etc. in this system, furthermore, since it has the amount of correlation with detection of truck correlation average not only before 1 period but before several round term is lost.

[0100] Next, other optical disk units are described. Since repeat machine learning falls when focal correlation is weak also in focal control, big deflection as a result remains. Then, when focal correlation

is weak, the gain of a control system is made to raise by carrying out adjustable [of the gain of the control system of a loop formation], and the flattery capacity of a control system over disturbance is raised. Since the control band is holding down ********** of learning control low by the rise of the gain of the above-mentioned control system to it even if the riser phase margin deteriorates in coincidence, a control system does not become unstable. When focal correlation is strong, a system with powerful flattery capacity is realizable to synchronicity, and focal correlation will be weak, namely, disturbance will mix if a focal control system is constituted as mentioned above, flattery capacity has strong composition to disturbance by the rise of control gain. Carrying out malfunction by the blemish, a defect, etc. in this system, furthermore, since it has the amount of correlation with detection of focal correlation average not only before 1 period but before several round term is lost.

[0101] Example 6 drawing 9 is a block diagram for carrying out correlation detection in the optical disk unit of the example 6 of this invention. In drawing, 12 shows study memory and 13 shows a digital filter.

[0102] Next, actuation is explained. Drawing 9 has separately the study memory 12 from which the capacity which memorizes the truck deflection of a disk 1 - n rotation quota differs, and after it makes weighting on frequency characteristics respectively the eccentric information memorized before 1 - n rotation by the digital filter 13, it has the composition of detecting correlation with the truck deflection in front of 1 truck, applying an absolute value. Drawing 11 is a block diagram for having separately the memory from which the capacity which memorizes the truck deflection of a disk 1 - n rotation quota differs, detecting correlation with the truck deflection in front of 1 truck, after making weighting on frequency characteristics respectively the eccentric information memorized before 1 - n rotation, and carrying out adjustable [of the amount of feedback gain of a tracking control system] based on the above-mentioned amount of correlation.

[0103] As opposed to the correlation value of the truck error signal of a before [1 - n truck of a truck error signal / in / on drawing 9 and / a control system] For example, while making the cut off frequency of a digital filter low at the correlation value (before number - n truck) using old information and removing a noise component enough It is made for the noise or disturbance in old information not to influence a correlation value by making the cut off frequency of a digital filter high at the correlation value using new information, and giving weighting which utilizes all information if possible.

[0104] Thus, when there is sudden disturbance, such as vibration and a blemish, neither a noise nor disturbance influences a correlation value by carrying out adjustable [of the cut off frequency of a digital filter], but high stability and flattery capacity can be acquired. Thus, if it carries out adjustable [of the loop gain of a control system] like drawing 11 based on the stable amount of correlation, the control band according to truck correlation can be appointed, and it will be thought possible to prevent the unnecessary band fluctuation by a blemish etc. moreover. Moreover, drawing 13 is a block diagram for having separately the memory from which the capacity which memorizes the truck deflection of a disk 1 - n rotation quota differs, detecting correlation with the truck deflection in front of 1 truck, after making weighting on frequency characteristics respectively the eccentric information memorized before 1 - n rotation, and carrying out adjustable [of the cut off frequency of a low-pass compensating filter] for companion a radical to the above-mentioned amount of correlation. Also when moving the multiplier of the low-pass compensating filter of a tracking control system like drawing 13 , band change sets unnecessarily by a blemish etc. and there is nothing. Furthermore, similarly, drawing 15 is a block diagram for carrying out adjustable [of the gain of the feedforward loop formation of a study compensator], and since the amount of correlation is stabilized also in this case, changing the gain of a study loop formation unnecessarily is lost.

[0105] It can respond with constituting from a case of a focal control system similarly. Drawing 9 has separately the study memory from which the capacity which memorizes the deflection of focal gap of a disk 1 - n rotation quota differs, and after it makes weighting on frequency characteristics respectively the face deflection information memorized before 1 - n rotation by the digital filter, it has the composition of detecting correlation with the deflection of the focal gap before 1 truck, applying an absolute value.

[0106] As opposed to the correlation value of the focal gap signal of a before [1 - n truck of a focal gap signal / in / on drawing 9 and / a control system] For example, while making the cut off frequency of a digital filter low at the correlation value (before number - n truck) using old information and removing a noise component enough It is made for the noise or disturbance in old information not to influence a correlation value by making the cut off frequency of a digital filter high at the correlation value using new information, and giving weighting which utilizes all information if possible.
[0107] Thus, when there is sudden disturbance, such as vibration and a blemish, neither a noise nor disturbance influences a correlation value by carrying out adjustable [of the cut off frequency of a digital filter], but high stability and flattery capacity can be acquired. Thus, if it carries out adjustable [of the loop gain of a control system] like drawing 11 based on the stable amount of correlation, the control band according to focal correlation can be appointed, and it will be thought possible to prevent the unnecessary band fluctuation by a blemish etc. moreover. Moreover, also when moving the multiplier of the low-pass compensating filter of a focal control system like drawing 13 , band change sets unnecessarily by a blemish etc. and there is nothing. Furthermore, similarly, as shown in drawing 15 , it is possible to carry out adjustable [of the gain of the feedforward loop formation of a study compensator], and since the amount of correlation is stabilized also in this case, changing the gain of a study loop formation unnecessarily is lost.
[0108] Example 7 drawing 10 is a block diagram for carrying out correlation detection in the optical disk unit of the example 7 of this invention. In drawing, the band pass filter with which, as for 12, study memory differs and, as for 14, Q value differs, respectively is shown.
[0109] Next, actuation is explained. Drawing 10 has separately the study memory from which the capacity which memorizes the truck deflection of a disk 1 - n rotation quota differs, and after it makes weighting by the band pass filter with which adjustable [of the Q value] was carried out to each the eccentric information memorized before 1 - n rotation, it has the composition of detecting correlation with the truck deflection in front of 1 truck, applying an absolute value. Drawing 12 is a block diagram for having separately the memory from which the capacity which memorizes the truck deflection of a disk 1 - n rotation quota differs, detecting correlation with the truck deflection in front of 1 truck, after making weighting by the band pass filter with which adjustable [of the Q value] was carried out to each the eccentric information memorized before 1 - n rotation, and carrying out adjustable [of the amount of feedback gain of a tracking control system] based on the above-mentioned amount of correlation.
[0110] As opposed to the correlation value of the truck error signal of a before [1 - n truck of a truck error signal / in / on drawing 10 and / a control system] For example, while making Q value of a band pass filter high at the correlation value (before number - n truck) using old information and removing a noise component enough It is made for the noise or disturbance in old information not to influence a correlation value by making Q value of a band pass filter low at the correlation value using new information, and giving weighting which utilizes all information if possible.
[0111] Thus, when there is sudden disturbance, such as vibration and a blemish, neither a noise nor disturbance influences a correlation value by carrying out adjustable [of the Q value of a band pass filter], but high stability and flattery capacity can be acquired. Thus, if it carries out adjustable [of the loop gain of a control system] like drawing 12 based on the stable amount of correlation, the control band according to truck correlation can be appointed, and it will be thought possible to prevent the unnecessary band fluctuation by a blemish etc. moreover. Moreover, drawing 14 is a block diagram in the case of moving the multiplier of the low-pass compensating filter of a tracking control system, and there is not [band change sets unnecessarily by a blemish etc. also in this case, and]. Furthermore, similarly, drawing 16 is a block diagram for carrying out adjustable [of the gain of the feedforward loop formation of a study compensator], and since the amount of correlation is stabilized also in this case, changing the gain of a study loop formation unnecessarily is lost.
[0112] It has the composition of detecting correlation with the focal gap deflection in front of 1 truck, applying [drawing 10 has separately the study memory from which the capacity which memorizes the focal gap deflection of a disk 1 - n rotation quota differs, and] an absolute value after carrying out weighting by the band pass filter with which adjustable [of the Q value] was carried out to each at the

face deflection information memorized before 1 - n rotation if adapted for a focal control system in this. It has separately the memory from which the capacity which memorizes the focal gap deflection of a disk 1 - n rotation quota differs, and after making weighting by the band pass filter with which adjustable [of the Q value] was carried out to each the face deflection information memorized before 1 - n rotation, correlation with the focal gap deflection in front of 1 truck detects to it, and it carries out adjustable [of the amount of feedback gain of a focal control system] to it in drawing 12 based on the above-mentioned amount of correlation.

[0113] As opposed to the correlation value of the focal gap signal of a before [1 - n truck of a focal gap signal / in / on drawing 10 and / a control system] For example, while making Q value of a band pass filter high at the correlation value (before number - n truck) using old information and removing a noise component enough It is made for the noise or disturbance in old information not to influence a correlation value by making Q value of a band pass filter low at the correlation value using new information, and giving weighting which utilizes all information if possible.

[0114] Thus, when there is sudden disturbance, such as vibration and a blemish, neither a noise nor disturbance influences a correlation value by carrying out adjustable [of the Q value of a band pass filter], but high stability and flattery capacity can be acquired. Thus, if it carries out adjustable [of the loop gain of a control system] like drawing 12 based on the stable amount of correlation, the control band according to focal correlation can be appointed, and it will be thought possible to prevent the unnecessary band fluctuation by a blemish etc. moreover. Moreover, also when moving the multiplier of the low-pass compensating filter of a focal control system like drawing 14 , band change sets unnecessarily by a blemish etc. and there is nothing. Furthermore, similarly, as shown in drawing 16 , it is possible to carry out adjustable [of the gain of the feedforward loop formation of a study compensator], and since the amount of correlation is stabilized also in this case, changing the gain of a study loop formation unnecessarily is lost.

[0115]

[Effect of the Invention] According to the optical disk unit of this invention according to claim 1, correlation with the truck deflection in front of 1 truck is detected using the memory which memorizes the truck deflection for disk 1 rotation, and a tracking control system is stabilized, without being influenced by sudden disturbance, such as vibration and a blemish of a disk, by carrying out adjustable [of the control band of a tracking control system] according to the amount of truck correlation by carrying out adjustable [of the loop gain of a tracking control system].

[0116] Moreover, according to the optical disk unit of this invention according to claim 2, correlation with the deflection of the focal gap before 1 truck is detected using the memory which memorizes the deflection of the focal gap for disk 1 rotation, and a focal control system is stabilized, without being influenced by sudden disturbance, such as vibration and a blemish of a disk, by carrying out adjustable [of the control band of a focal control system] according to the amount of correlation of focal gap by carrying out adjustable [of the loop gain of a focal control system].

[0117] Moreover, according to the optical disk unit of this invention according to claim 3, correlation with the truck deflection in front of 1 truck is detected using the memory which memorizes the truck deflection for disk 1 rotation, and the high tracking control system of flattery capacity can be constituted, without being influenced by sudden disturbance, such as vibration and a blemish of a disk, by carrying out adjustable [of the cut off frequency of the low-pass compensating filter of a tracking control system].

[0118] Moreover, according to the optical disk unit of this invention according to claim 4, correlation with the deflection of the focal gap before 1 truck is detected using the memory which memorizes the deflection of the focal gap for disk 1 rotation, and the focal high control system of flattery capacity can be constituted, without being influenced by sudden disturbance, such as vibration and a blemish of a disk, by carrying out adjustable [of the cut off frequency of the low-pass compensating filter of a focal control system].

[0119] Moreover, according to the optical disk unit of this invention according to claim 5, correlation with the truck deflection in front of 1 truck is detected using the memory which memorizes the truck

deflection for disk 1 rotation, and since the gain of the loop formation of learning control is not unnecessarily changed even if there is sudden disturbance, such as vibration and a blemish of a disk, by carrying out adjustable [of the amount of attenuators in the feedforward loop formation of the study compensation section], the learning-control system in tracking control is stabilized.
[0120] Moreover, according to the optical disk unit of this invention according to claim 6, the memory which memorizes the deflection of the focal gap for disk 1 rotation is used. Even if there is sudden disturbance, such as vibration and a blemish of a disk, by detecting correlation with the focal gap deflection in front of 1 truck, and carrying out adjustable [of the amount of attenuators in the feedforward loop formation of the study compensation section] Since the gain of the loop formation of learning control is not changed unnecessarily, the learning-control system in focal control is stabilized.
[0121] Moreover, according to the optical disk unit of this invention according to claim 7, the memory covering a part for disk 1 rotation - number rotation from which capacity differs, respectively is used. By memorizing the truck deflection before disk 1 rotation - number rotation, and comparing with current truck deflection By detecting correlation with the average with the truck error in front of the truck which is carrying out current flattery, and a 1 - number truck Without being influenced by sudden disturbance, such as vibration and a blemish of a disk, flattery capacity is high and an extremely stable control system can consist of optical disk units of above-mentioned claim 1 - claim 6.
[0122] Moreover, according to the optical disk unit of this invention according to claim 8, the memory which memorizes the truck deflection for disk 1 rotation is used. Correlation with the truck deflection in front of 1 truck is detected. Without being influenced by sudden disturbance, such as vibration and a blemish of a disk, by changing the study degree of control repeatedly and carrying out adjustable [of the loop gain of a tracking control system], while carrying out adjustable [of the cut off frequency of the low-pass compensating filter of a tracking control system] with high flattery capacity A tracking control system without malfunction can be constituted.
[0123] Moreover, according to the optical disk unit of this invention according to claim 9, the memory which memorizes the deflection of the focal gap for disk 1 rotation is used. Correlation with the deflection of the focal gap before 1 truck is detected. Without being influenced by sudden disturbance, such as vibration and a blemish of a disk, by changing the study degree of control repeatedly and carrying out adjustable [of the loop gain of a focal control system], while carrying out adjustable [of the cut off frequency of the low-pass compensating filter of a focal control system] with high flattery capacity A focal control system without malfunction can be constituted.
[0124] Moreover, according to the optical disk unit of this invention according to claim 10, it has separately the memory from which the capacity which memorizes the truck deflection of a disk 1 - n rotation quota differs. After making weighting on frequency characteristics respectively the eccentric information memorized before 1 - n rotation, Without being influenced by sudden disturbance, such as vibration and a blemish of a disk, by detecting correlation with the truck deflection in front of 1 truck, and carrying out adjustable [of the amount of feedback gain of a tracking control system] based on the above-mentioned amount of correlation The tracking control system with which the amount of correlation which serves as criteria in the decision of control gain was stabilized more can be built.
[0125] Moreover, according to the optical disk unit of this invention according to claim 11, it has separately the memory from which the capacity which memorizes the focal gap deflection of a disk 1 - n rotation quota differs. After making weighting on frequency characteristics respectively the face deflection information memorized before 1 - n rotation, Without being influenced by sudden disturbance, such as vibration and a blemish of a disk, by detecting correlation with the focal gap deflection in front of 1 truck, and carrying out adjustable [of the amount of feedback gain of a focusing control system] based on the above-mentioned amount of correlation The focal control system with which the amount of correlation which serves as criteria in the decision of control gain was stabilized more can be built.
[0126] Moreover, according to the optical disk unit of this invention according to claim 12, it has separately the memory from which the capacity which memorizes the truck deflection of a disk 1 - n rotation quota differs. After carrying out weighting by the band pass filter with which adjustable [of the

Q value] was carried out to each, Memorize in each memory group and correlation with the truck deflection in front of 1 truck is detected. The tracking control system with which the amount of correlation which serves as criteria in the decision of control gain was stabilized more can be built without being influenced by sudden disturbance, such as vibration and a blemish of a disk, by carrying out adjustable [of the amount of feedback gain of a tracking control system] based on the above-mentioned amount of correlation.
[0127] Moreover, according to the optical disk unit of this invention according to claim 13, it has separately the memory from which the capacity which memorizes the focal gap deflection of a disk 1 - n rotation quota differs. After carrying out weighting by the band pass filter with which adjustable [of the Q value] was carried out to each, Memorize in each memory group and correlation with the focal gap deflection in front of 1 truck is detected. The focal control system with which the amount of correlation which serves as criteria in the decision of control gain was stabilized more can be built without being influenced by sudden disturbance, such as vibration and a blemish of a disk, by carrying out adjustable [of the amount of feedback gain of a focal control system] based on the above-mentioned amount of correlation.

[Translation done.]

* NOTICES *

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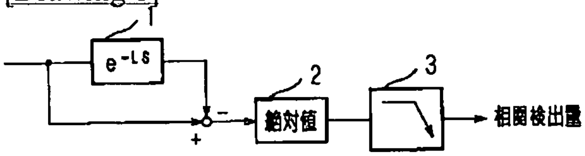
damages caused by the use of this translation.

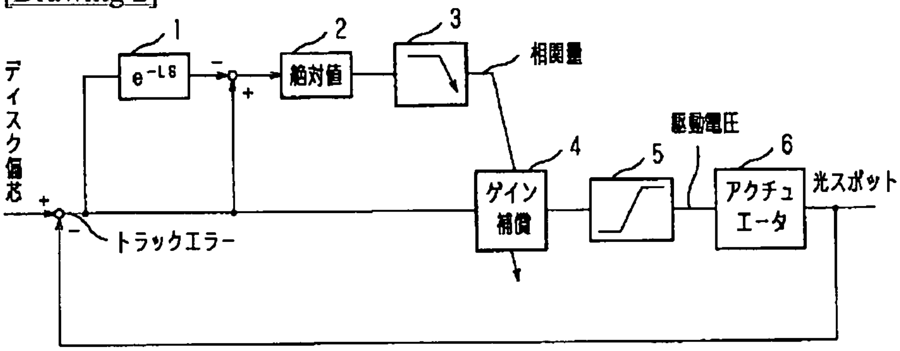
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

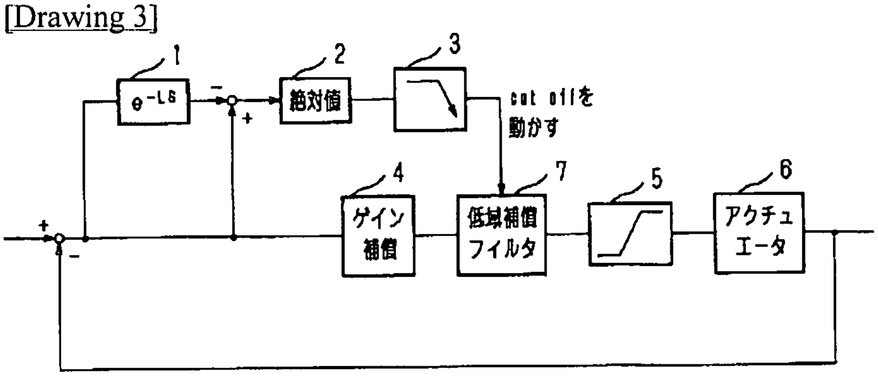
[Drawing 1]



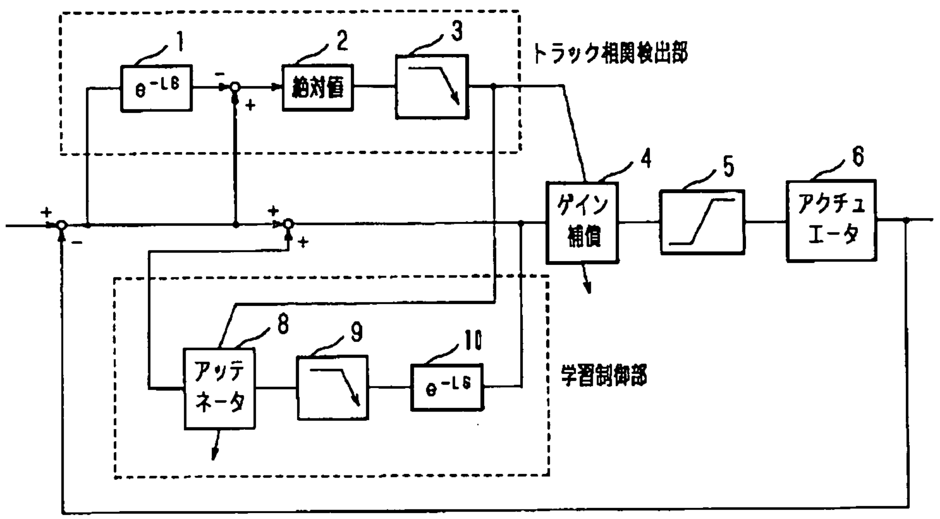
[Drawing 2]



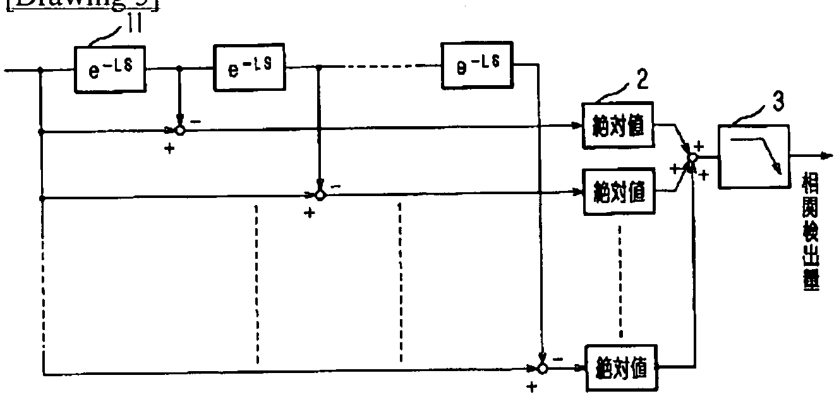
[Drawing 3]



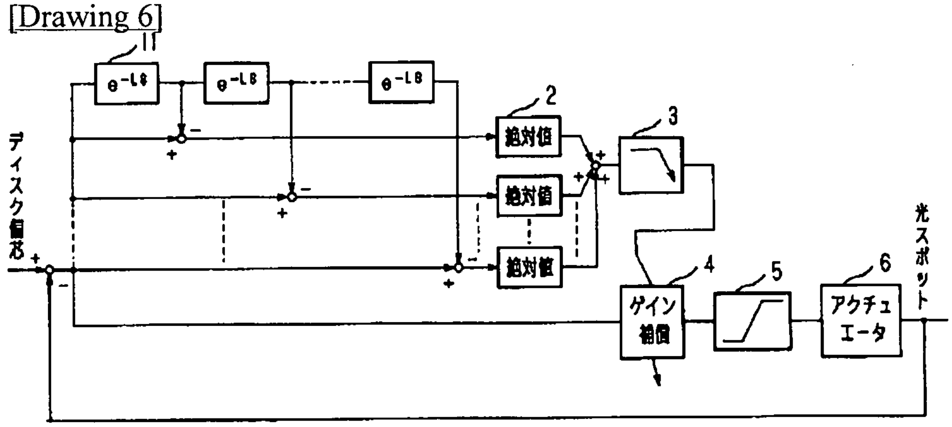
[Drawing 4]



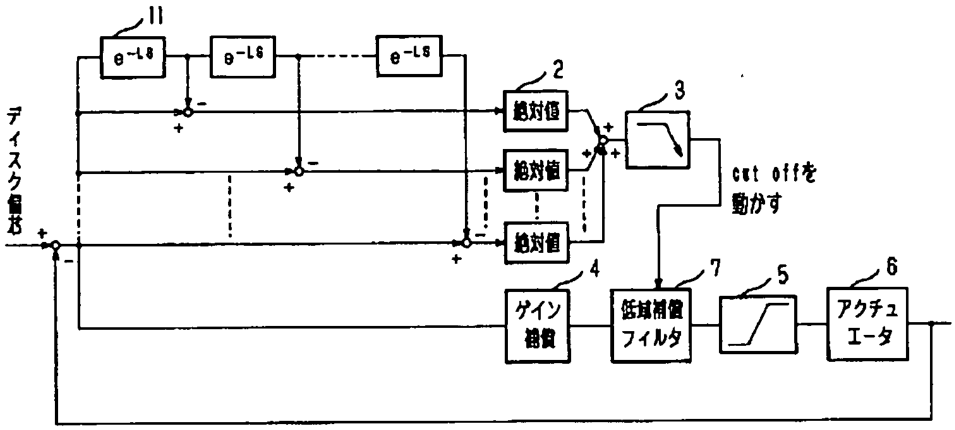
[Drawing 5]



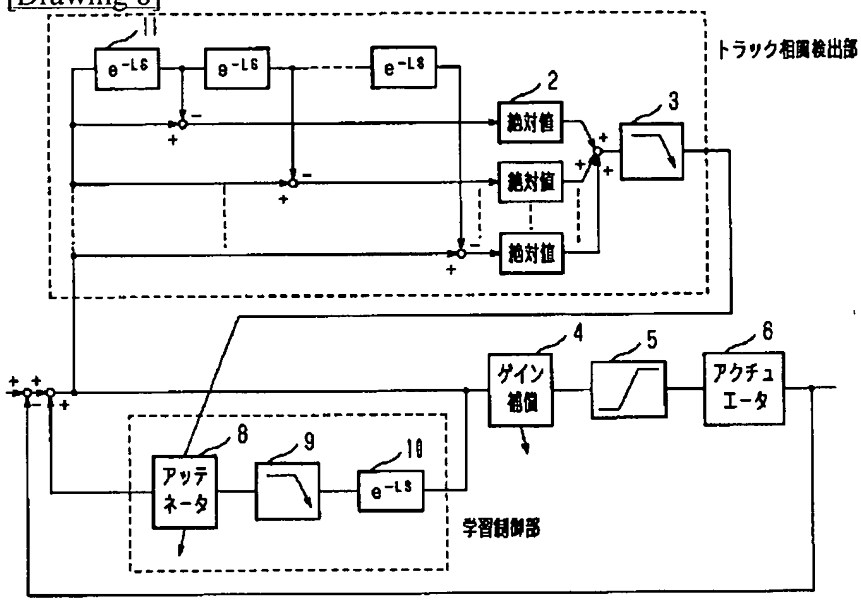
[Drawing 6]



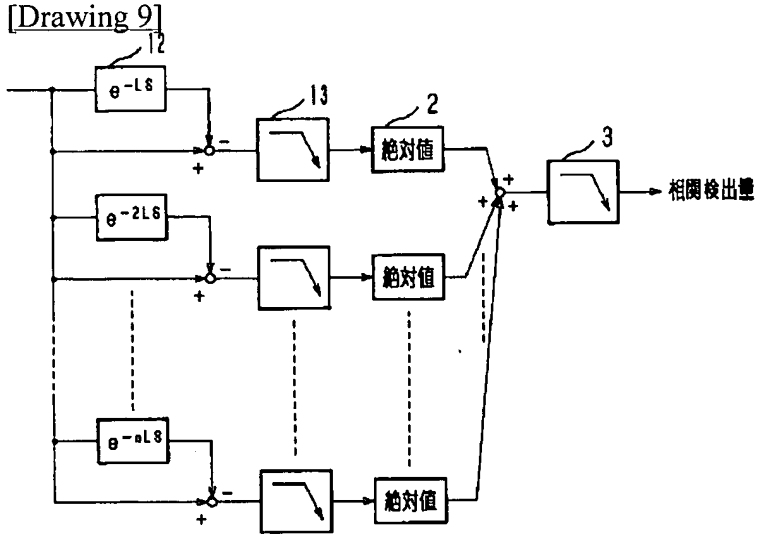
[Drawing 7]



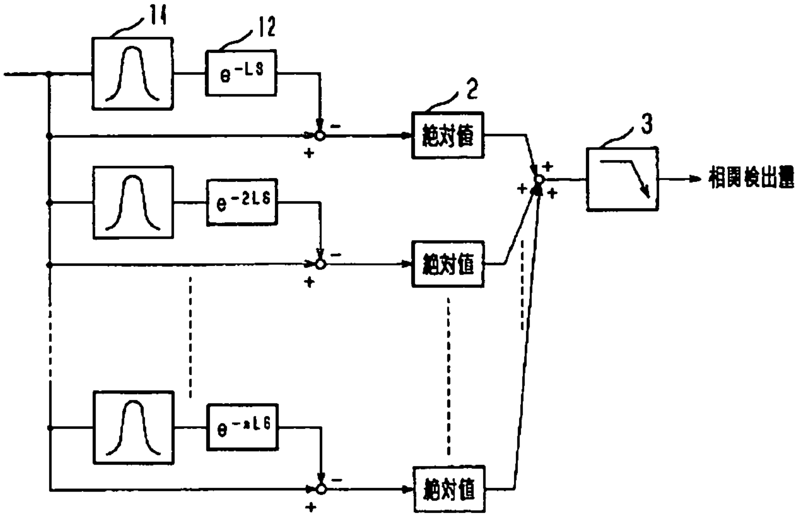
[Drawing 8]



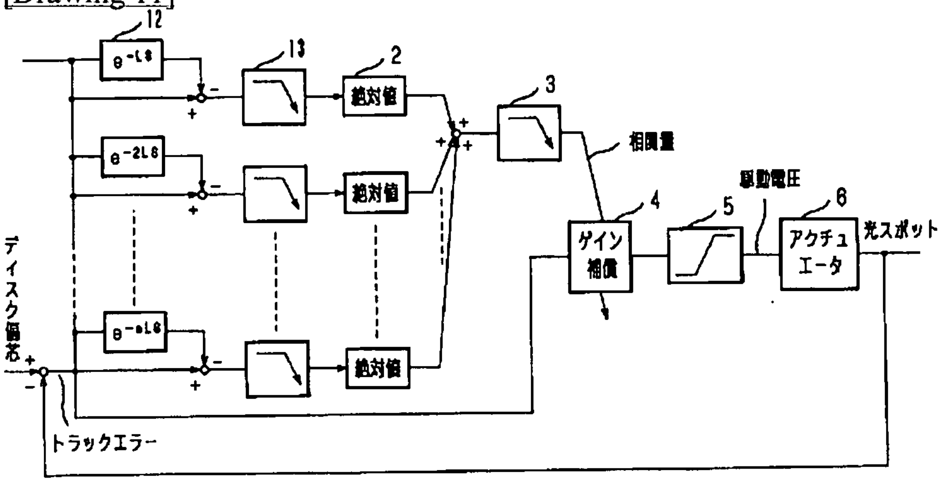
[Drawing 9]



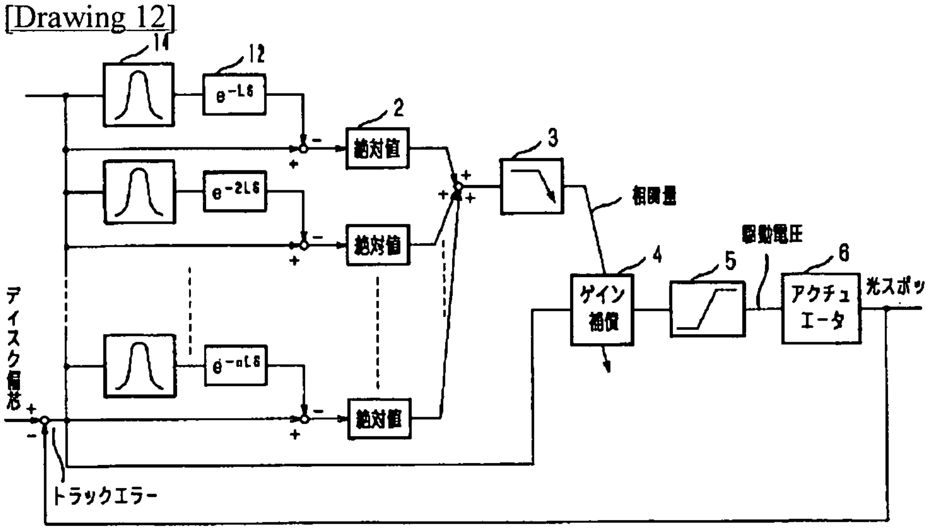
[Drawing 10]



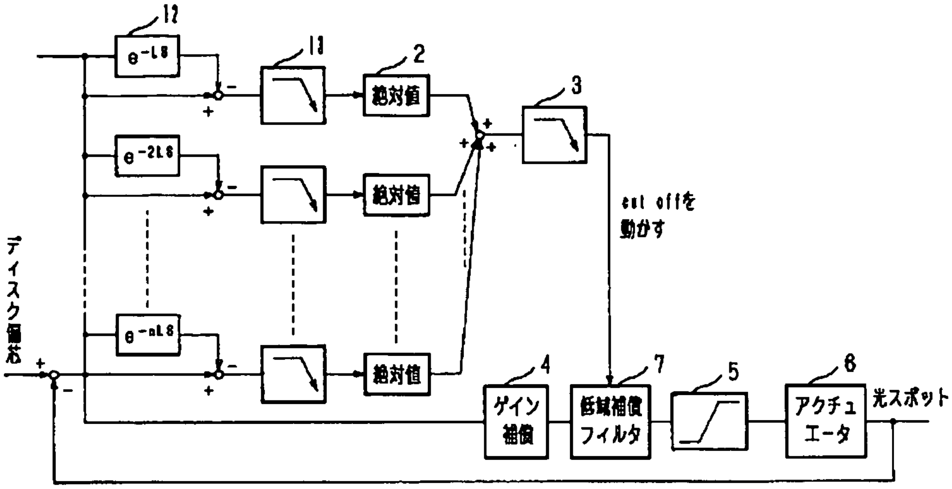
[Drawing 11]



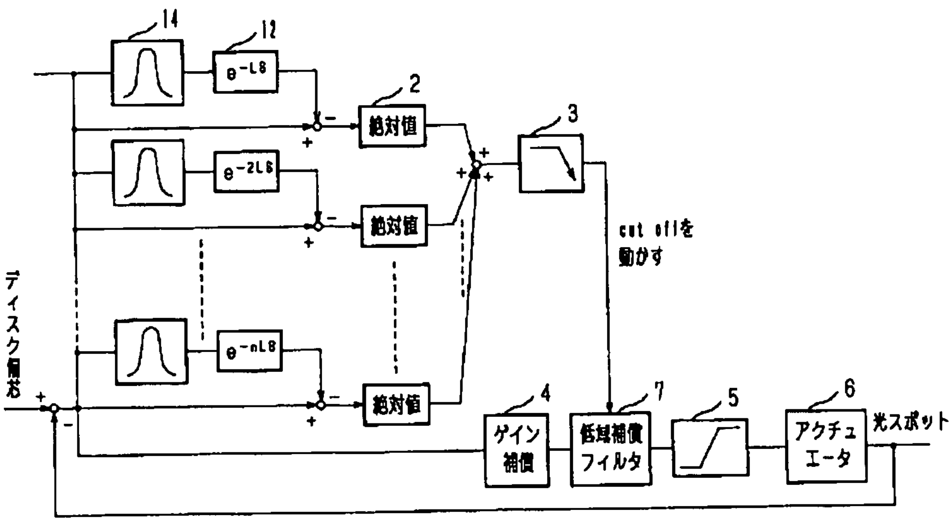
[Drawing 12]



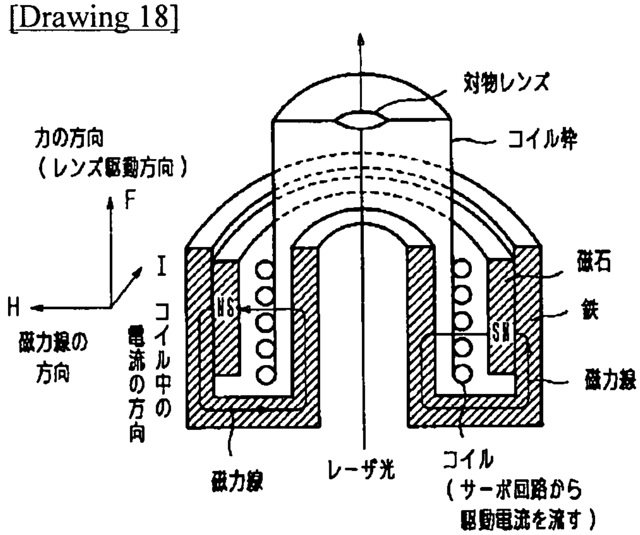
[Drawing 13]



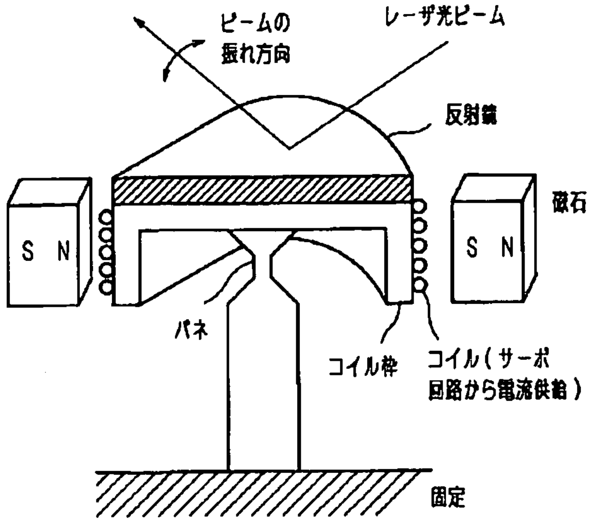
[Drawing 14]



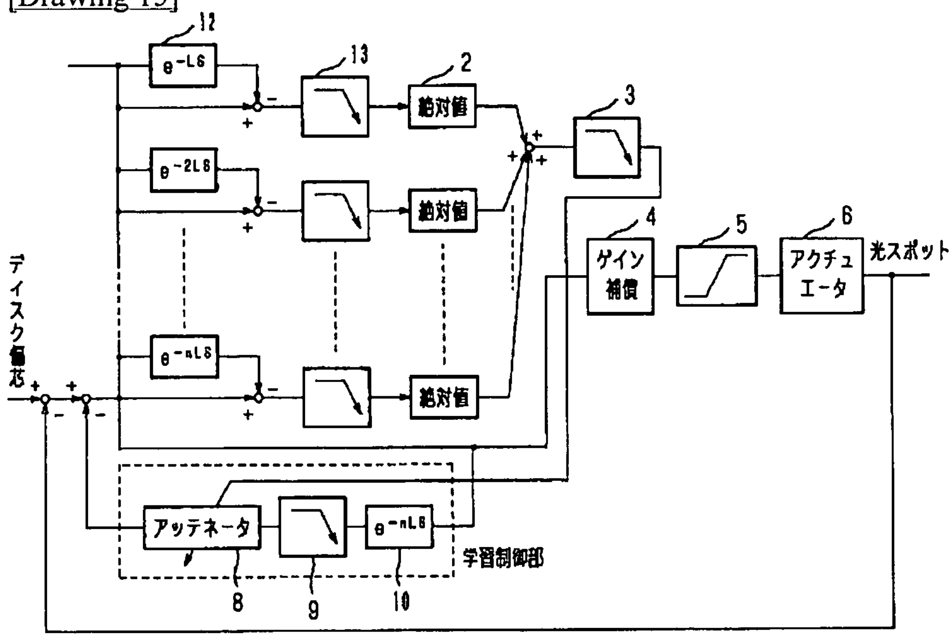
[Drawing 18]



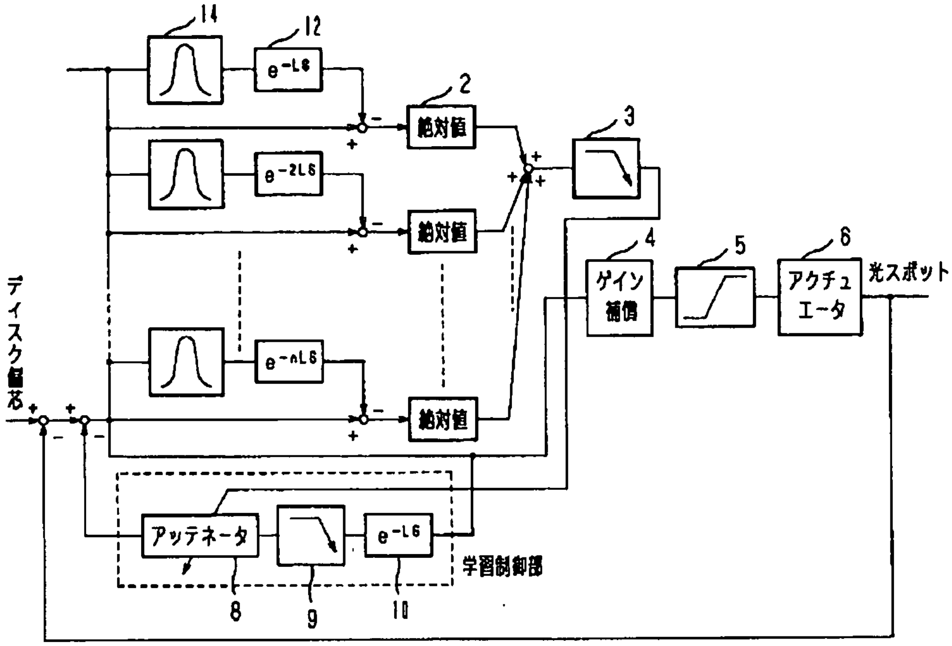
[Drawing 19]



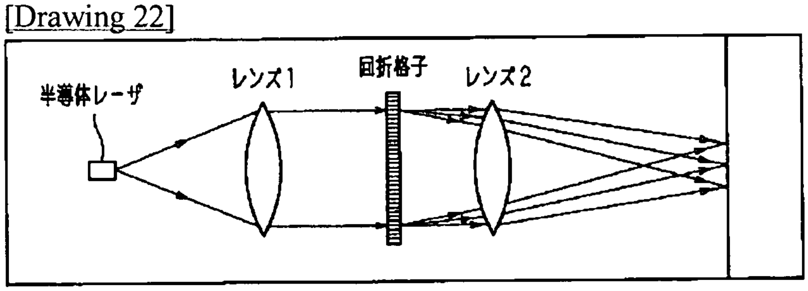
[Drawing 15]



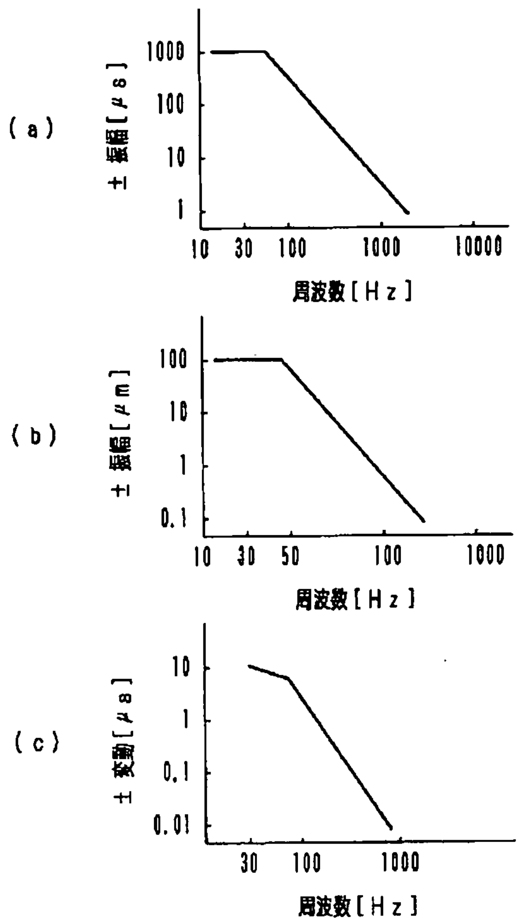
[Drawing 16]



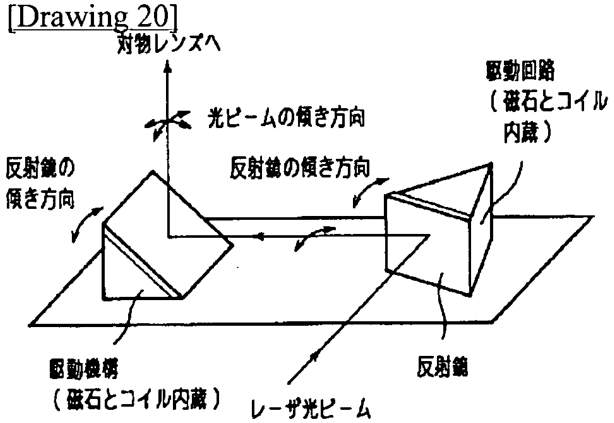
[Drawing 22]



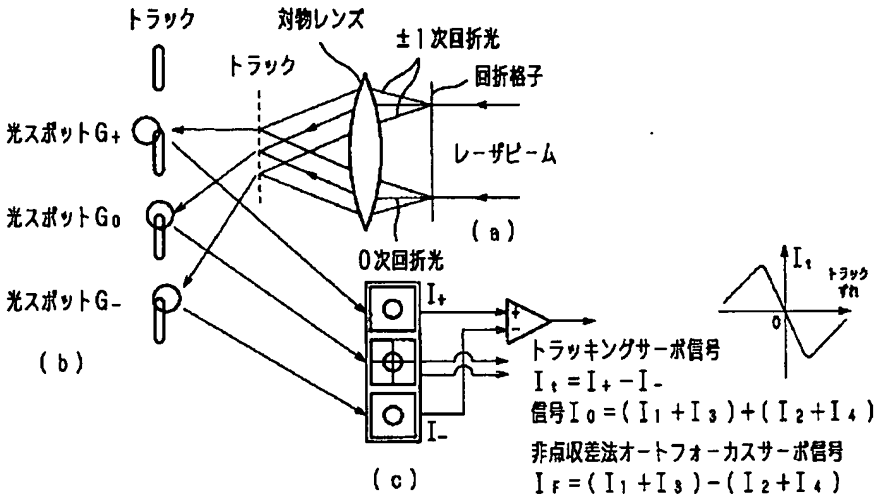
[Drawing 17]



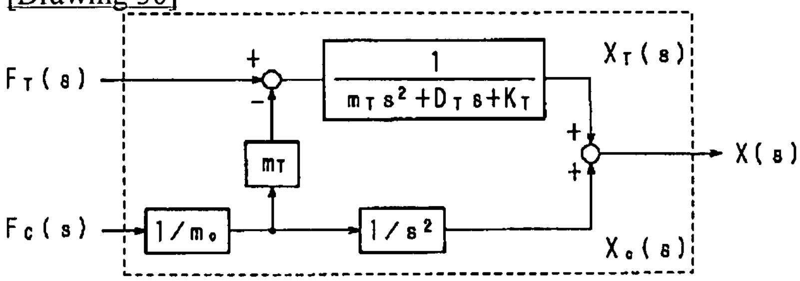
[Drawing 20]



[Drawing 21]

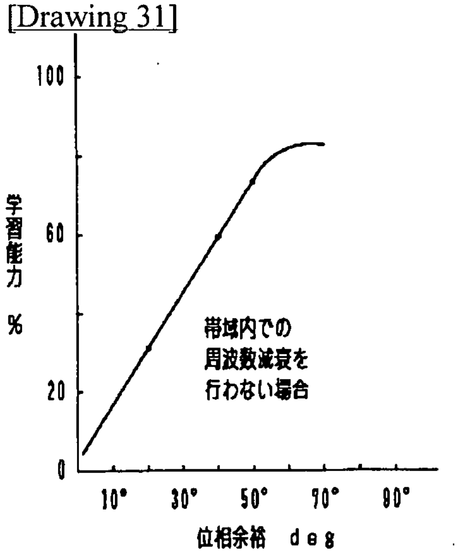


[Drawing 30]

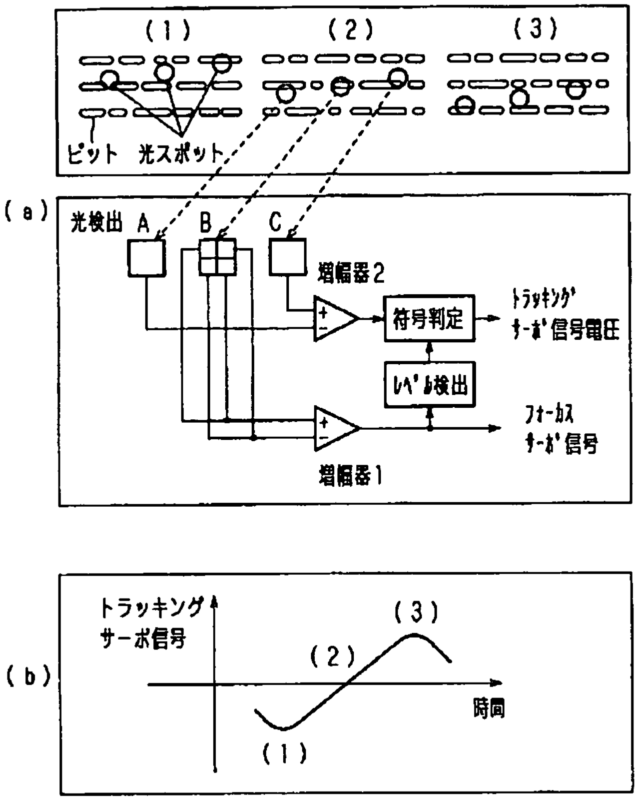


G(s)：2入力1出力系の伝達関数

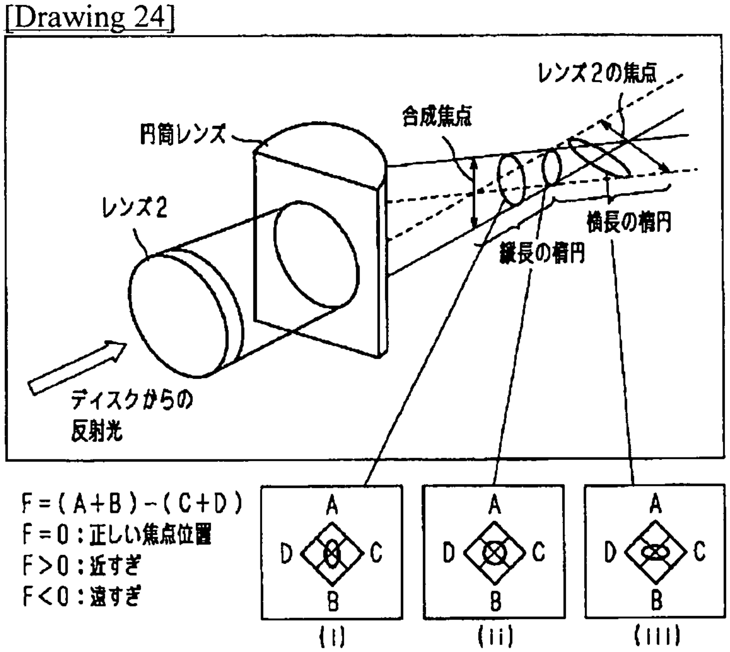
[Drawing 31]



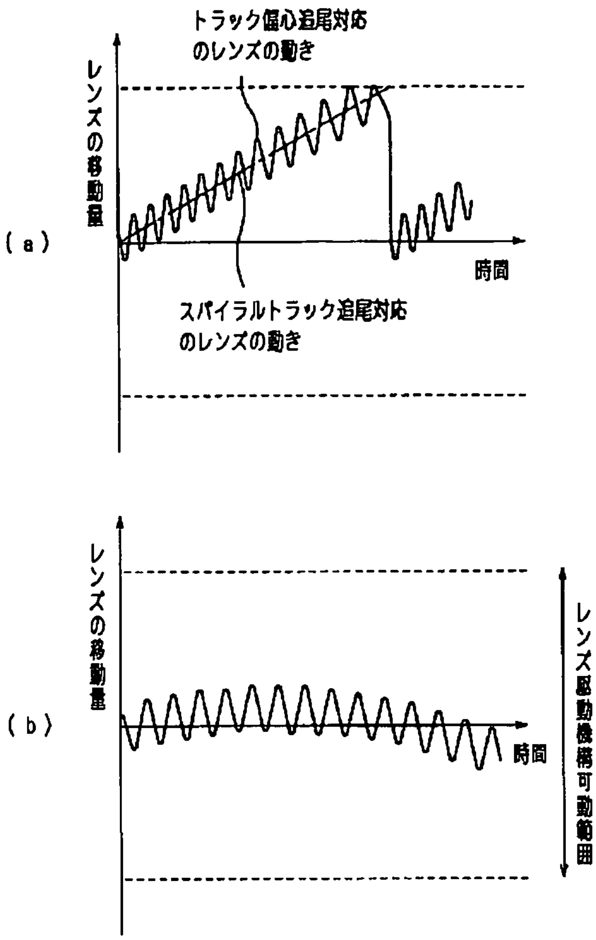
[Drawing 23]



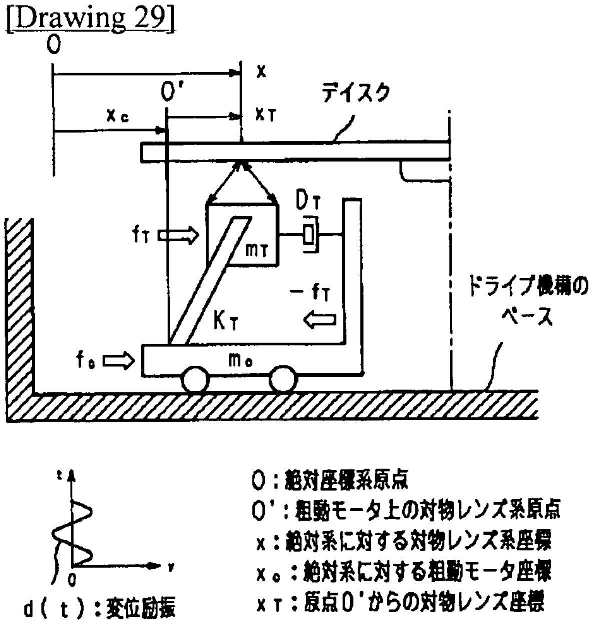
[Drawing 24]



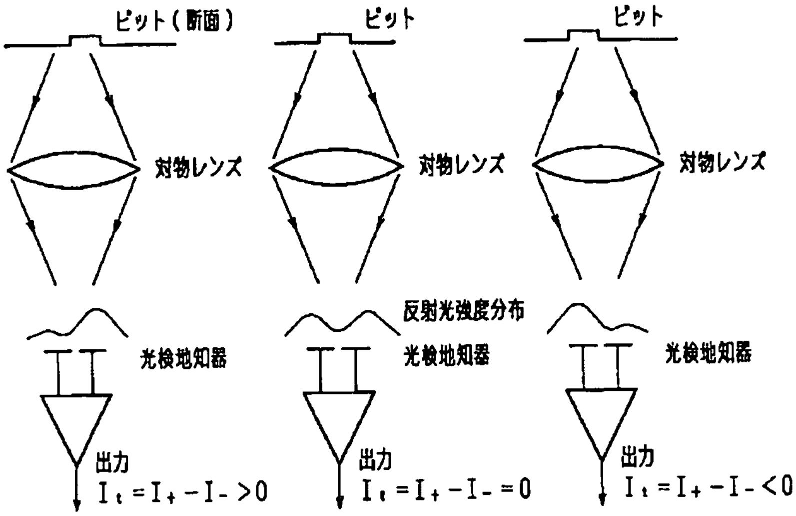
[Drawing 28]



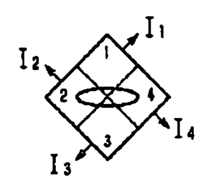
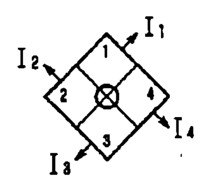
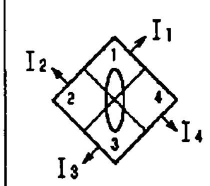
[Drawing 29]

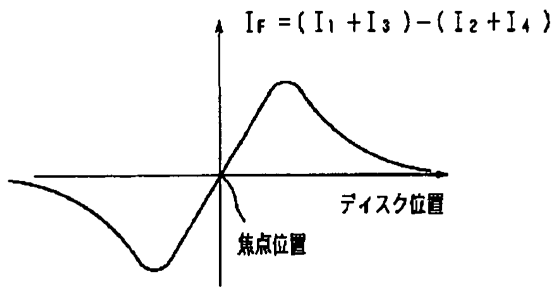


[Drawing 25]

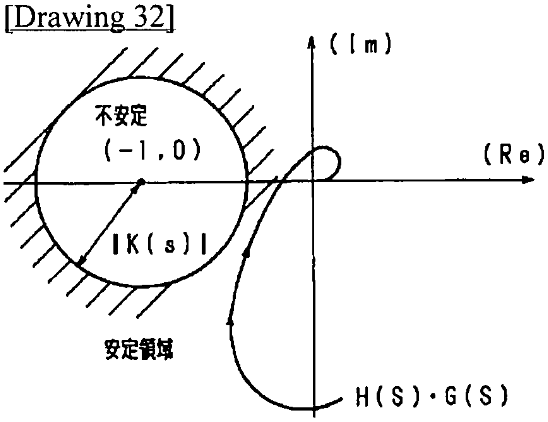


[Drawing 26]

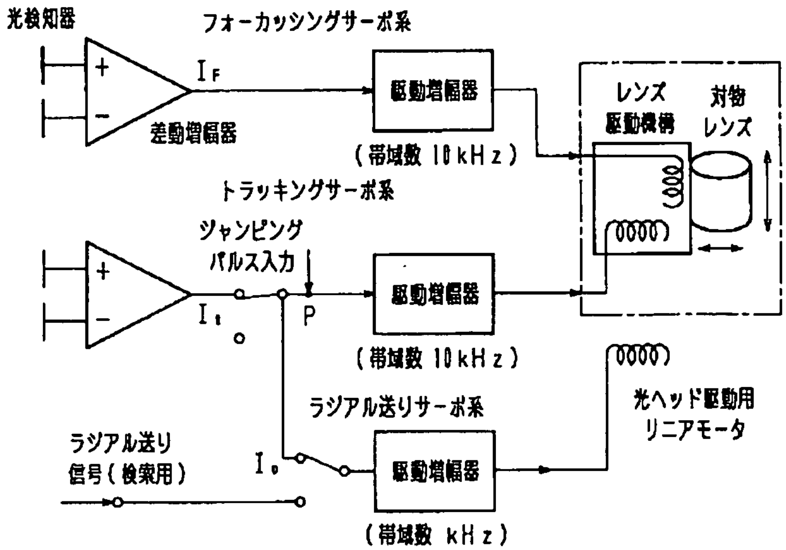
ディスク位置	（1）レンズから遠ざかりすぎ	（2）焦点位置	（3）レンズに近すぎ
光検知器上の光スポット形状			



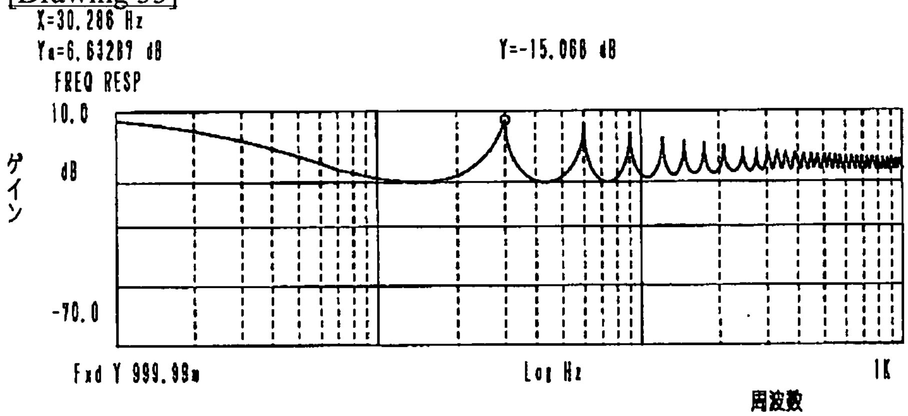
[Drawing 32]



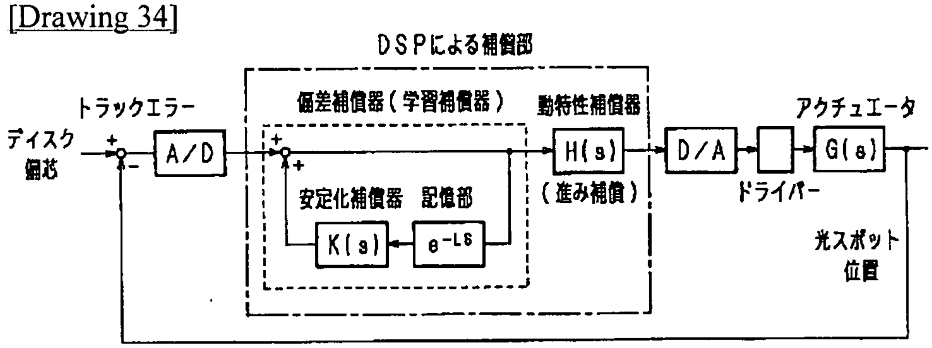
[Drawing 27]



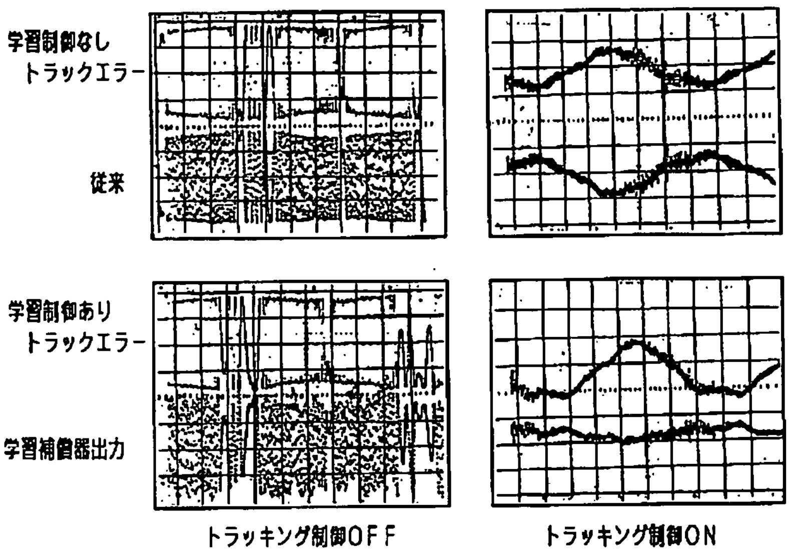
[Drawing 33]



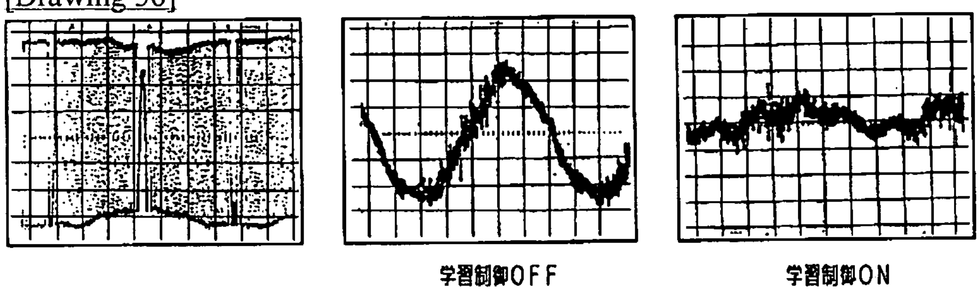
[Drawing 34]



[Drawing 35]



[Drawing 36]



[Translation done.]